SOIL CONSERVATION

Index

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BEGINNING
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WELLINGTON BRINK — EDITOR

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

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CONTROL MEASURES MEET CHALLENGE OF HEAVY RAINS

Torrential spring rains dramatically spotlighted the value of erosion control in midwest and southwest. A round-up of field reports from a wide frontage firmly underscored all the forecasts that had been made as to the probable effectiveness of the coordinated program of the Soil Conservation Service in checking losses of soil and water. Dust Bowl measurements showed increased moisture storage, Corn Belt and Wheat Belt tabulations brought out greater detention of run-off—as a result of contour furrowing, strip cropping, terracing, grass-seeding, tree-planting and other measures.

H. H. Bennett, Chief of the Service, wired from Garland that erosion control practices on demonstration areas in eastern Texas proved 95 percent effective in withstanding the impact of heavy rains with respect to preventing soil losses. This performance was in sharp contrast to what happened on unprotected neighboring lands, where another tragic chapter was added to the record of erosion.

Grass Succeeds

On the erosion experiment station at Tyler, Texas, Mr. Bennett reviewed the results of a downpour which was record-breaking as to intensity. Here soil was swept away from a cotton field at the rate of 63 tons per acre, with 31 percent of the rainfall lost in immediate runoff, whereas under a shawl of grass in an adjoining field, soil held 100 percent, and the water runoff amounted to but 0.3 of 1 percent.

Out in Iowa, where nearly 7 inches of rain fell in 90 minutes, establishing a 50-year high mark, 12,000 unprotected acres gave up more than 2.5 inches of their best soil, according to R. E. Uhland, regional conservator.

He wrote:

> Bridges were washed out, fences destroyed, livestock killed, and other property was severely damaged. Corn fields, plowed land and areas planted with grass mixtures this spring suffered the most damage. In many instances plowed fields, and particularly hillsides, were washed to the subsoil. Some bottomland pastures were buried beneath two feet of soil from untreated, cultivated fields nearby.
>
> The land protected by erosion-control structures presented a sharp contrast. Terraced fields lost comparatively little soil because the water drained away slowly, leaving the soil in the fields where it belonged. Pastures and fields with cover crops lost

(*Continued on p. 7*)

SAVINGS-DEPOSITS OF MOISTURE

At time of going to press, the best available estimate indicated that more than **2,000,000 acres** in the five-State emergency area had been contour-listed previous to the rainy spell in May. This included operations in the demonstration projects.

Observations of moisture penetration showed that, roughly, **1 inch** of additional subsoil moisture was retained as a result of the contour practice.

The late report from H. H. Finnell, Regional Conservator, comments:

"This serves to wet the soil slightly more than **1 foot** deeper than was accomplished without contouring.

"According to determined water usage for this area. this is capable of adding, if efficiently utilized, **3,600,000 bushels** of grain to the normal production and approximately **500,000,000 pounds** of additional protective residue for the prevention of wind erosion next spring and winter.

"On the basis of recorded experiments, the surety of crop production has been increased about **75 percent**."

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DR. BENNETT TALKS ON FLOOD CONTROL

That the most effective form of flood levee is a blotterlike vegetative covering of farm lands was maintained in an address by H. H. Bennett, Chief of the Soil Conservation Service, before the annual meeting of the New York State Society of Professional Engineers, May 23rd.

Paying tribute to the intelligence and efficiency of the engineering fraternity in its long single-handed fight to protect life and property from the periodical threat of high waters, the speaker brought to his audience a conviction that erosion can be controlled at its source and the task of disciplining unruly streams of the Nation thus made easier.

His words were particularly timely and effective because they were projected against the sounding board of Pittsburgh's and Johnstown's recent tragedies and to the accompaniment of torrential rainstorms and current floods in many scattered sections of the country.

Mr. Bennett's message follows:

Seeking Permanent Solution

As some of you may know, I entertain and have expressed, from time to time, some pretty definite ideas about flood control. As engineers, you gentlemen entertain some pretty definite ideas of your own. Some of you may not agree with me; I, in turn, may disagree with some of you. But the mere fact that you are willing to devote a part of your time during this meeting to the subject of soil erosion control, seems to indicate that we are rapidly getting together. When we do, I am confident that we shall all be a great deal nearer a permanent solution of the flood-control problem.

In the past, our approach to that solution has been highly specialized. The whole difficult problem of flood control has been turned over to the engineering profession because it has been regarded almost entirely as a matter involving the design and construction of down-stream levees, spillways, revetments, and dams. Within the limitations of available funds, the profession has met the responsibility thus placed upon it with a remarkable degree of success in harnessing the channelways of major streams.

Agriculture a Partner

But now, it seems to me the flood-control picture is changing. We in the field of soil conservation feel that we have a very definite and important contribution to make in controlling floods. The evidence accumulated during the relatively few years since this country began to consider soil erosion a matter of major concern leads me to the conviction that the problem of flood control requires action not only by the engineer, but by the agriculturist as well.

Don't misunderstand me. I question neither the importance of the engineer in the field of flood control nor the value of his work. On the contrary, I believe that this nation cannot afford to curtail the construction or hamper the progressive design of engineering works for flood control. Such works are essential.

Getting at the Source

But are they alone sufficient from the standpoint of maximum effectiveness? I do not think so. Levees, spillways, and revetments are downstream fortifications at the point of greatest danger, where flooded rivers bulge from their banks to devastate lands, crops and property. What of the point of origin of flood waters? Is it possible to cope with floods only after our rivers have become raging and destructive torrents? Or can we tackle the problem at its source—on the sloping lands of watersheds, where flood waters accumulate and silt loads are picked up? I am convinced that we can.

After all, flood waters start as rainwater and melting snow. Floods are made up of raindrops, infinitely multiplied. If we force them to move slowly and evenly into drainage-ways, it seems logical to expect a decrease in the volume and velocity of water poured into our trunk rivers by their tributaries.

Soil Fills Channels

Soil stripped from our fields—millions of tons of it a year—is dumped into waterways, shoaling channels, clogging reservoirs, or continuing on to the oceans. Huge deposits of erosional debris must certainly diminish the carrying capacity of numerous water courses, large and small.

Even more important, both as a flood hazard and as a cause of soil erosion, is the denudation of sloping lands. Vegetation retards runoff water, binds the soil in place against the wash of rain and the drifting of wind, and preserves the top layer of productive and absorbent soil. Without this absorptive and productive topsoil layer, land sheds water at an astonishing rate. Moreover, the millions of gullies—man-induced waterways that usually form after the surface soil has been stripped off—discharge runoff water into neighboring streams with maximum speed.

Example of Absorption

As an illustration, consider what happens when a pitcher of water is spilled on the surface of a tilted wooden table. The water rushes off immediately and forms a puddle on the floor. But what happens if the hard wooden surface is covered with a blotter and then a heavy Turkish towel? Most of the water is absorbed; the excess is impeded and spread in its downward flow by the nap of the towel.

Studies at our erosion experiment stations in 13 major agricultural regions show very conclusively that the same thing happens in nature. The topsoil, humus-filled and made porous by the

burrowing of earthworms, insects, and the roots of plants, is highly absorptive—a blotter for rain. Vegetation, like the nap of the towel, forms countless tiny impediments to the downhill flow of rain water the soil is unable to absorb. But when vegetation and the topsoil are removed, rainwater rushes across the impervious subsoil surface about as rapidly as the water that rushed across the wooden surface of an inclined table. Even before erosion has proceeded to the point of subsoil exposure, vegetation and vegetative litter, functioning as a screen, serve to keep open the hidden conduits of the soil by preventing their clogging with eroded soil carried in suspension.

Research Yields Evidence

Let me give you quickly a few highly pertinent findings from representative erosion experiment stations. On an 8-percent slope in Missouri, land cropped continuously to corn has lost year after year an average of 28 percent of the total precipitation as immediate run-off. On another part of the same slope, planted to alfalfa, only 4.5 percent of the precipitation has been lost. Corn, as you know, is clean cultivated and covers only a fraction of the ground surface. Alfalfa, on the other hand, is close-growing and soil-binding and, covers all of the ground. Grass has exerted much the same restraining effect on run-off.

Soil losses accompanying these water losses have been at annual rates of 67 tons per acre from corn land, 0.28 tons from alfalfa fields, and 0.33 tons from grass. From bare soil (fallow, kept clean of all vegetation), the water loss has amounted to 29 percent of the total precipitation and the soil loss has been at the rate of 105 tons an acre.

Corn Versus Bluegrass

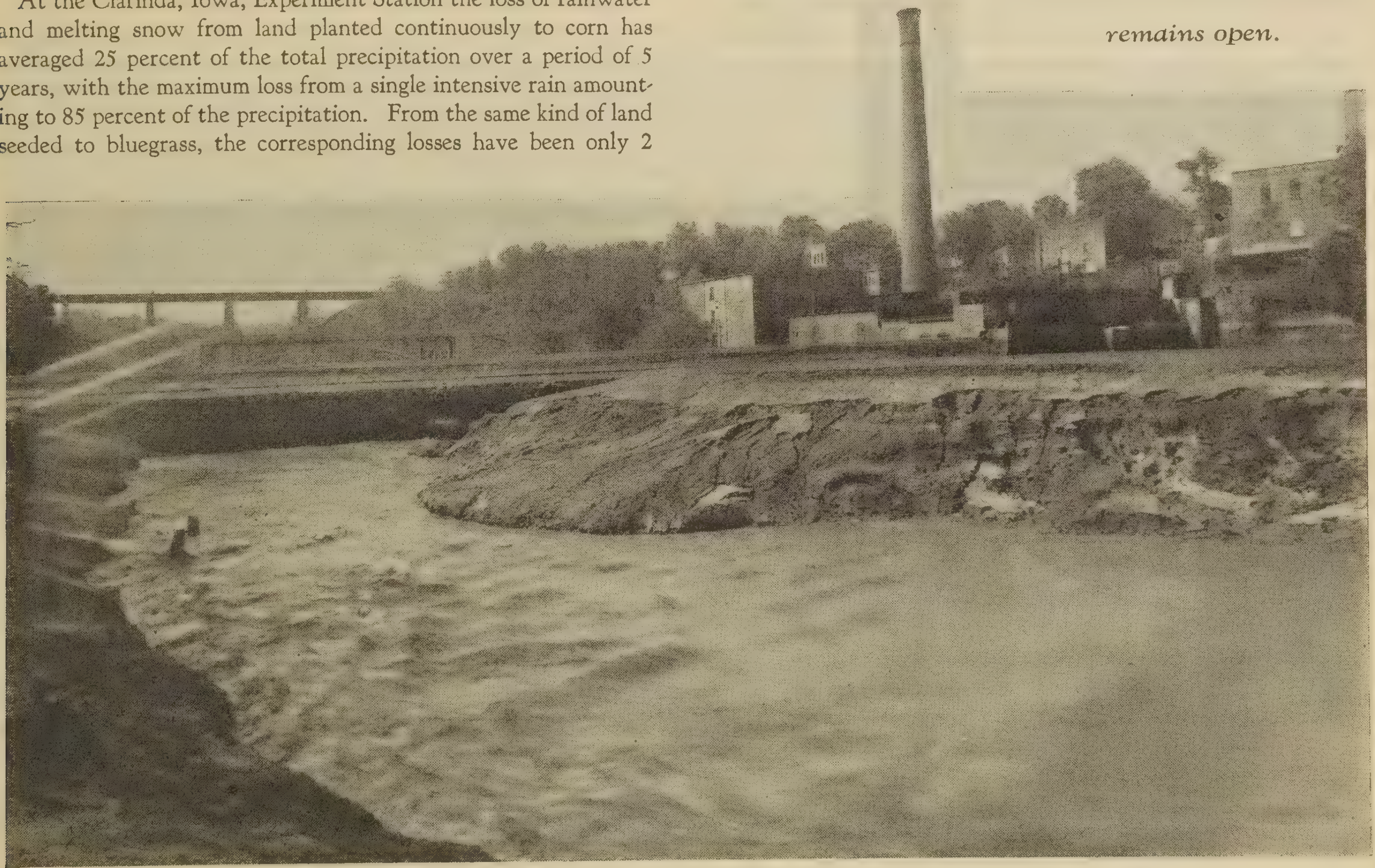
At the Clarinda, Iowa, Experiment Station the loss of rainwater and melting snow from land planted continuously to corn has averaged 25 percent of the total precipitation over a period of 5 years, with the maximum loss from a single intensive rain amounting to 85 percent of the precipitation. From the same kind of land seeded to bluegrass, the corresponding losses have been only 2 percent of all rains and 14 percent of the maximum from a single rain. It is interesting to observe that at the same station 100 percent of the precipitation from a single torrential rain ran off a cornfield having a slope of somewhat greater length than the other fields referred to.

I could cite similar examples from many parts of the country. Naturally, the rate of run-off varies from locality to locality because of variations in soil, character of rainfall, type of agriculture, and other factors. But our experiments have shown beyond any question that the run-off of rainwater is enormously reduced where the land retains its natural cover or a substitute. Measurements made on a large number of extensive and distinct types of agricultural soils have shown that, on the average, land covered with trees, grasses, legumes and similar close-growing crops absorb five times as much rainfall as the same kind of land planted to clean-tilled crops, such as corn, tobacco, and cotton. We cannot, of course, grow our crops in the woods or keep all our fields in grasses and legumes. But we can devote the steeper, more erodible slopes to forest, meadow, or permanent pasture, and protect our cultivated fields by strip cropping, rotating tilled crops with legumes and grass, growing winter cover crops, increasing the humus supply of the soil, terracing, contour tillage, and interrupted furrowing—all of which practices largely increase the absorption of both rainfall and melting snow.

Meadow Proves Superior

You will be interested, I believe, in a recent report by Dr. F. B. Howe, of Cornell University, on the relationship between erosion

Silt deposit in the Converse, S. C., reservoir. Only the narrow stream channel remains open.



Sheet erosion on field disked up and down slopes, near Guide Rock, Nebr.

and floods in New York City. Studies carried on near Ithaca, according to Dr. Howe, showed that a single acre of corn land lost as run-off 127,000 gallons, or 6.37 inches, more water during one growing season than an acre of comparable meadow land on another part of the same slope.

In an imaginary watershed of one million acres, planted entirely to corn, land of the same kind would, with the same precipitation, pour 134 billion gallons of water into drainage channels during the growing season. Run-off from the same area in meadow, would amount to only 7 billion gallons.

Potato Field Losses

Other measurements at the Ithaca erosion experiment station during the period from March 1 to 19, 1936, or just preceding the 1936 flood on that stream, are equally indicative of the effectiveness of vegetation in controlling run-off. Water losses from two potato fields amounted to 75 and 82 percent of the precipitation, respectively, on land having a slope of 14 percent. Of 9.47 inches of rain and snow, 7.1 and 7.85 inches, respectively, were lost as run-off during this critical period. In contrast, the corresponding losses from neighboring forested areas, with a gradient of 27 percent, were less than 0.5 percent of the precipitation.

The major damage from erosion, of course, is to the land. Our surveys indicate that approximately 50,000,000 acres of once-fertile land has been essentially ruined for practical cultivation. Another 50,000,000 acres is in a condition almost as serious. About 100,000,000 acres more, still largely in cultivation, has been seriously impoverished by the loss of topsoil; and on another 100,000,000 acres the depredations of erosion are getting actively under way.

Multiple Effects

But the effects of erosion do not end with the damage to the land. The soil washed from sloping fields and pastures—not less than three billion tons of it a year—is either poured into streams, reservoirs, harbors, and the oceans, or is deposited along lower slopes and over alluvial flood plains. Sometimes these deposits are beneficial to the land—more often they do great damage. Probably two-thirds of the vast load comes to rest in river channels, power and water supply developments, or is stranded elsewhere on its interrupted journey to tidewater. Scant attention has been given the matter of sedimentation. But recent studies indiate quite clearly that we shall have no permanent water-storage systems until we have curbed erosion along the headwaters of contributing streams.

For example, in 1925, Elk City, Oklahoma, constructed a water-supply reservoir costing over $325,000. Six years later, excessive silting made it necessary to raise the spillway two feet to provide adequate storage. In August 1933 engineers estimated that the reservoir had lost 48 percent of its original capacity because of silt. At the present time, the city is making plans for constructing a new reservoir because the impounded water is insufficient for municipal needs. The watershed that supplies water to this city is over 85 percent under cultivation.

As recently as 1930, the City of Waco, Texas, completed a storage reservoir. This reservoir has filled over 12 percent with silt, or at the approximate rate of 2½ percent a year. If this present rate of silting continues, the storage capacity will be entirely exhausted in another 35 years.

Damage in the Piedmont

In the Southern Piedmont region, numerous small reservoirs and many of major capacity, not more than a few decades old, are completely filled, except for a normal stream channel through the silted area of the original pond. Scores of these smaller reservoirs, with dams 10 to 30 feet high and equipped to generate electric current, are practically obsolete. Thirteen major reservoirs in the Carolinas and Georgia have been silted to the top of the dam within less than 36 years.

Let's return for a moment to the relation of eroding slopes to flood hazards. Recent measurements indicate that in a single year enough silt to form a prism one mile square and 164 feet high lodges in the channel of the Mississippi, between Cairo, Illinois, and Baton Rouge, Louisiana. Into the river every year go some 447 million cubic yards of soil material that erosion has taken from the land. Two-thirds of this enormous load is transported to the sea. One-third lodges in the channel and along the banks of the great stream. That can only mean, it seems to me, that the ability of the river to remain within its banks is being constantly diminished.

Flood Levels Rising

The record would seem to bear me out. Nine years ago the Mississippi rose out of its banks in the wildest rampage of which we have any record. Water rose to 45.8 feet on the gauge at Memphis—the highest mark ever registered there. The preceding highwater mark registered on the same gauge was 43.4 feet in 1916. Before that, the highest reading was 35.6 feet, back in 1890.[1]

[1] Floods in the United States, p. 320, Water-Supply Paper No. 771, U. S. Geological Survey, 1936.

Mississippi flood levels are rising, it appears, in spite of all we have done along that stream to hold floods in check. New records of flood heights were established along many waterways this year. Levees were thrown up over night at Washington in March in order to protect Government buildings, and they performed the service asked of them. Pittsburgh was less fortunate; the levees couldn't be built in time.

Levees 4,000 Years Ago

The Chinese call the Hwang Ho "China's sorrow." Four thousand years ago, the Chinese were building engineering works to hold this great river to its course. They built levees and canals, and excavated silting pools. But in 1878 it broke from its banks and drowned a million people.

The Chinese attempted to deal with floods just as we deal with them—at their point of greatest strength—and they failed. Northwestern China was once a vast expanse of forested highlands. The forests were cut down, and the steep slopes were brought into cultivation. Much of that area is now devastated, stripped of its topsoil by rainwash. Gullies have cut to depths of 600 feet. Millions of Chinese farmers have moved to the lower alluvial plains along the rivers, and concentrated there, a constant prey to the greater and more frequent floods that have resulted from removing the vegetative cover from the land. America has made the same mistake and continues to do so. But now that this error has been discovered, I believe we shall move forward on a new and more complete basis.

Chinese Go Forward

The Chinese appear, finally, to be thinking in this direction themselves: A letter received from a member of the technical staff of the National Geological Survey of China, written from Nanking April 24, 1936, has this to say about flood control in that country:

I have been greatly interested in soil erosion and its control, and also in the proper utilization of land. These problems are very acute in China and we are brought into close contact with them almost every day in connection with our work. . . . The flood control engineers . . . are talking of the necessity of watershed protection. We have the same difficulty here as in America—that of attacking the problem as a whole.

Aiding Nature

Soil conservation as practiced by farmers cooperating with the Soil Conservation Service in 41 States involves little more, fundamentally, than the use of nature's methods of erosion and flood control as I have outlined them. These farmers apply a coordinated plan of attack, utilizing many methods in which each distinctive piece of land is used and treated in accordance with its natural adaptabilities and economic needs. Instead of leaving fields smoothly worked over and bare, inviting erosion, the idea is to roughen the surface, turn the earth and the plants into impediments to runoff and protectors of the soil. By the simple device of plowing and cultivating around the hills, along the contour, instead of up and down the slopes, each furrow, each harrow scratch, becomes in effect a small dam or terrace. Reinforced by grass or other cover when the land is resting, with the steeper, more erosive slopes retired to forest or permanent grass, these measures, along with many others, stop a vast amount of water from running off into the streams. On the less stable slopes required for cropping purposes more elaborate methods are used. Here man must supplement the hand of nature with terraces, diversion ditches, and other measures. But the principle remains the

Railroad washout, Bath, N. Y., during high waters of July 1935.

Eroded field near Mankato, Kansas.

same—to make running water creep and, as it creeps, sink into the soil.

And I think you will agree that man cannot build a reservoir so huge and so effective as the soil itself.

Agriculture, to be sure, cannot offer you a substitute for flood water fortifications down the river. I am not in any sense proposing that. But agriculture can offer a multitude of reinforcements on the land where floods begin. When we shall have mutually agreed to a simple procedure of cooperation and coordination, it is my conviction that we shall then be moving in the right direction.

Nothing is to be gained, I feel, in devoting endless time to arguing our theories. Too much work is awaiting us—all of us—to waste precious time. But one point seems to need some clearing up. Occasionally someone questions the statement that the denudation of land contributes in any considerable degree to floods. In this connection we are frequently reminded that when De Soto first saw the Mississippi it was in flood—long before the ax or plow were known to America; and we are reminded again and again that we always have had floods.

Floods Inevitable

Well, I agree. Of course, we always have had floods; and until come cataclysmic change upsets our existing regime of climate, we always shall have them. Geologists will tell you that the whole mass of material forming the alluvial plain of the Mississippi was deposited and spread out by floodwaters through a process of slow land development—sedimentation—which had its beginning millions of years before De Soto discovered the river. The meandering of the Mississippi through its self-built plain since infinitely ancient time is recorded in the geological characteristics of this material. The records show beyond any question that there have always been floods along that mighty stream, as along every other stream bordered with an alluvial plain. But the records show considerably more than that.

Overlying the old alluvial soils of numerous streams throughout the United States—the material laid down by timeless floods—is a different kind of alluvium. It consists of sediments spread out by floodwaters since the beginning of our agriculture. Such deposits reveal unmistakable proof that, generally, they were spread over the flood-plains by waters much more violent than those which laid down the vastly older material beneath.

That the deposits of the pre-agricultural stage developed under moderate overflows is shown by their prevailing finer texture and more uniform composition. The line of separation between the two types of alluvium is so sharp that it is usually possible to photograph it without any difficulty. In many instances, the depth of the new material is greater than the entire depth of the older underlying deposit, and generally, it is not only coarser in texture, but far more diverse with respect to textural composition and color characteristics through the profile.

The Bureau of Chemistry and Soils is today mapping a number of new alluvial soils entirely different in character from those of pioneer days, now entirely buried. We have the history of these soils. We know denfitely that they have formed since the agricultural occupation of the country, and there is ample proof that these later deposits were laid down by more violently flowing waters than those of former times.

I mention this simply by way of assuring those who are skeptical of some of the things our soil conservationists are saying, that we are not separating ourselves from careful, technical investigations of the premises upon which we are basing our convictions, our plans, and our earnest desire to be understood, to help and to be helped.

We must start our attack at the point of cause and carry it through, step by step, to the point of effect. Flood control must begin at the crests of the ridges and extend down across the slopes to the stream, and then to the great trunk rivers that empty into the sea. In the meantime, of course, downstream operations may be vigorously prosecuted.

Erosion and floods are allies in destruction. We must ally our forces to defend ourselves against them both.

TWO BUREAUS JOIN FORCES ON SOILS PROBLEMS

Soil correlation problems of the Soil Conservation Service are the concern of a committee appointed under provisions of a supplemental memorandum of understanding with the Bureau of Chemistry and Soils. To this committee the Service will turn for correlation of all soil series and types identified and classified as part of the erosion map in conservation surveys, for advice as to the grouping of soil series and types as to erodibility, for assistance in the establishment of soil-type and soil-phase legends for approved survey projects, and for help in the grouping of soils on cooperative surveys with States preparatory to the publication of reports or maps.

Committee members are announced as Dr. Mark Baldwin, chairman; W. E. Hearn and T. D. Rice, for the Bureau of Chemistry and Soils; E. D. Fowler and A. E. Kocher, for the Soil Conservation Service. Alternates are the inspectors of the two agencies. The correlation and nomenclature of soil series and types become final when approved by the Chief of the Soil Survey Division.

Contact with the joint committee will be effected through the regular administrative channel, the Section of Conservation Surveys.

To Use Existing Facilities

The basic memorandum approved by the Secretary of Agriculture in January and the supplemental memorandum of April were born of an earnest desire to bring to bear on the erosion problem the experience, the accrued information, and the exceptional personnel of the older organization. It is also anticipated that the plan of cooperation will increase the use of soil survey reports and maps and will thereby multiply their value.

The basic memorandum clearly defines the responsibilities of the two Bureaus and designates meeting points for cooperative effort. It recognizes the Bureau of Chemistry and Soils as having sole jurisdiction over identification, classification, correlation, nomenclature, and mapping of soils, and charges it with the duty of publishing all soil maps. It recognizes the Soil Conservation Service as having full mandate for carrying on investigations and operations in erosion control, in connection with which it must make farm-by-farm surveys. The Soil Conservation Service is given the responsibility for making erosion surveys which show four factors, i. e., degree of erosion, percent of slope, type of soil, and present land use or cover. Cooperation with other federal and state agencies in the making of soil surveys is to be effected by the Bureau of Chemistry and Soils. In the making of erosion surveys and in connection with soil conservation projects, such cooperation will be by the Soil Conservation Service. Credit will be given for data obtained from either agency, upon its publication or release for publication by the other.

Detailed arrangements for soil and erosion surveys provide for the mutual exchange of information and for the detailing of certain personnel of the Bureau of Chemistry and Soils to the Soil Conservation Service.

Publication of Maps

As a result of the joint sifting of ideas and the definition of spheres of activity, soil conservation workers will have the twofold advantage of the present authentic and consistent soils maps (published by B. C. S.), and of erosion maps (published by S. C. S.) carrying degree of erosion and slope and cultural features, such as forests and grass cover.

CONTROL MEASURES

(Continued from p. 1)

practically no soil because the binding roots and vegetation prevented the water from concentrating in a channel where it could run off rapidly.

Ready for Rain

When late May rains broke the drought in the Southern High Plains, 1,916,910 contour-tilled and thirsty acres were in readiness to drink up the unaccustomed moisture and store it away for time of need. H. H. Finnell, regional conservator of Region 6, says that this readiness may prove the difference between a crop success and a crop failure and, in any case, will increase production and provide a cover better capable of resisting the winds of 1936 and 1937.

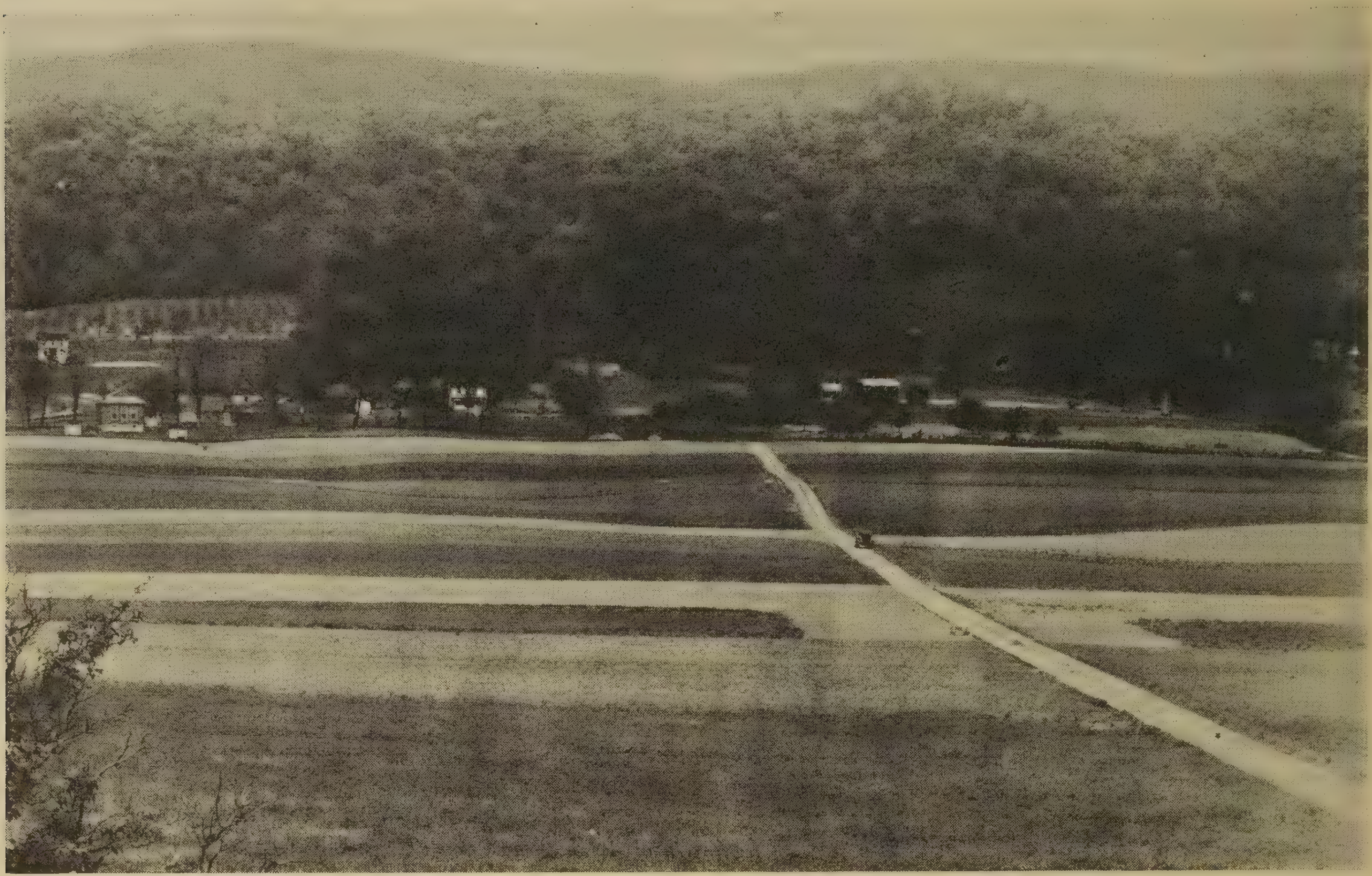
Engineers of the Soil Conservation Service ran many a contour line in the course of this broad-scale emergency-listing program and distributed 650,000 pounds of sorghum seed for use in providing cover crops on otherwise vulnerable lands.

Many farmers in the area have written to Mr. Finnell to tell of the bounty they have received from the water-conservation and soil-conservation measures

(Continued on p. 14)

THE PLACE OF THE FORESTER IN SOIL CONSERVATION

By John F. Preston [1]



"The forester, by training and experience, has been thinking in terms of land values for one-third of a century. His philosophy of land use is that of the long look ahead; he deals in values which require decades to develop. The forester lays his plans with the thought that generations must elapse before his results properly can be evaluated and the economic conditions of the present are but a factor in the parade of the years. Land values have been as much a resource to him as the timber which demanded his special attention."—D. S. Jeffers in the Journal of Forestry, May 1935.

We have been wasting our soil through misuse for a very long time. Land which was once held in place by prairie grass or primeval forest has been cleared of the soil and water holding cover; it has been yielding its substance to agricultural crops which in turn have sustained our civilization during the years since the pioneer first broke ground for a wilderness farm. Not realizing that his methods were wrong, that the life-giving soil itself was being slowly but surely carried away by the rain upon which he depended to water his crops, the farmer has been pursuing his relentless course until disaster threatens both him and the nation which is dependent upon the soil. Dotted all over this country are abandoned farms, and thousands of others which are rapidly reaching the stage of abandonment. Worn-out soil cannot produce a profitable crop and cannot support the farmers.

Forest Reclaims Land

The sustaining power of the forest to hold the soil, the ability of nature to reclaim worn-out land by the reestablishment of trees, is proved by the forests which have grown to maturity on what was once cleared crop-land. All through the eastern states we can find the old stone fences in the midst of newly-grown forests, which marked the site of old fields. The corn rows can still be distinguished in the dense second growth forest. Wild apple trees, decendents of farmers' orchards, attest the power of the forest to

[1] The author is head of the Woodlands Section, Soil Conservation Service.

reclaim and hold the soil. In Vermont, Daniel Webster once made a speech to a great gathering of country folk. The land was cleared at that time, and there was plenty of room for the crowd. It was a gala day—the crowds milled about over a great expanse of country. Today that spot is far back in the wilderness. The land which was then farms was abandoned because the soil was worn out, and the forest again took possession.

Long-Time Thinking

It is not strange then, that the forester has been called in as one of the doctors to treat the sick farms. He is the master of the best means for soil conservation; he must be a big factor, for only a forest can reclaim the steep eroded lands cast off by the agriculturists. The training and experience of a forester make him peculiarly adaptable to soil conservation work. He has always been accustomed to land-use planning; the very nature of his work requires long-time thinking. He is accustomed to making maps; one of the chief things that he learns is how to put a square mile of land on a square inch of paper; he is a rough and ready surveyor; soils, slopes, contours, and ridges, are all familiar subjects. The forester is likely to prove more and more useful in the work of soil conservation.

Love for the Land

Soil conservation takes on more or less the character of a crusade. A most valuable and indispensable national resource is rapidly slipping away. The job is to convince the nation that something must be done about it. Here again foresters are experienced, for they have been through a forestry crusade to convince the nation that forests are essential to its well being, and I think we can safely say that the crusade has been successful. Such an undertaking requires imagination, vision, and above all a love for the land. The forester has proven that he has imagination; he also has vision—he could hardly be a forester without it. He must look a long time into the future, for his trees require oftentimes a century or more to grow. He is forced to look a long way ahead to the possibilities in a changing world. He also has a love for the land; he is an out-of-doors man; he loves the hills and streams; he has a sense of topography and he has been long familiar with the birds and

The part of the farm which is now in woods must be made to produce its share of the farm income.

Worn-out soil cannot produce a profitable annual crop; if planted to forest trees the soil will gradually be restored and an income from woodland obtained.

the beasts and the shrubs; the forester is in tune with the land; he is in sympathy with it; he appreciates its beauty, its fertility and its usefulness to man. He is more appreciative of these qualities than are the farmers themselves, because he is able to see the land in perspective. The forester is by training and by inherent characteristics fitted for the soil conservation job.

Chasing His Woodland

Just what is involved in the problem of soil conservation? Most of the farms in the eastern part of the country contain from 10 to 60 percent of their area in some kind of forest growth. Some of it is in land that was once cleared. Down South, the farmer has been chasing his woodland from one end of his farm to the other during the last hundred years. He clears the forest in one place while it springs up again on the fields abandoned, in another. Everywhere, he has cut it and culled it, and often almost ruined it for productive use by maltreatment. Grazing animals have trampled the young trees and packed the soil, and fires have been allowed to burn unchecked. The methods of cultivation have failed to hold the soil on many of the fields which in increasing numbers are cast aside for crop or pasture use and become "idle lands" capable of reclamation only by the forest.

The farmers' income now comes mostly from two-thirds to one-half, or even less, of his farm area, and that proportion through soil erosion is fast decreasing, and can be saved only by strip-cropping, by terracing, and other soil husbandry practices. The part of the farm which is now in woods or which must be planted to forest trees in order to save it, must be made to produce its share of the farm income.

The Forester's Task

That is the forester's task; it is his job to aid other farm specialists by making the forest pay its share. The farmer must use his forest not only for its soil-building and soil-healing properties on land worn out for crops, but he should get a cash income from it. The farmer has been accustomed to think of his woods as merely so much of his farm which cannot be farmed. True, he has drawn on it for years for his house logs,

(Continued on p. 14)

POINTERS ON GULLY CONTROL IN MIDDLE WEST

By Ray E. Penn[1]

1. Divert as much water as possible from gullies, being careful not to cause others.

2. The use of earthen dams and diversion ditches is more satisfactory in gully control in pastures. Such structures are essential in the control of alkali spots.

3. Use check dams only where they are necessary to handle water than can neither be diverted nor controlled by vegetation alone. Certain shrubs, forbs, and grasses may serve as check dams. Trees should be used with caution, and only solid plantings of them should be made.

4. Where check dams are used, they should be spaced at vertical intervals of not more than 30 inches with the weir of one about level with the base of the one above.

5. Where plantings or seedings are made or natural revegetation is expected, provide for keeping the velocity of the water low enough for such plants to grow.

6. Depend upon the plants that come in naturally, wherever such a course can be justified.

7. If plantings or seedings are imperative, select species that will thrive without heavy costs for seeding and fertilizing, and provide effective year-long cover.

8. Let nature build up the soil so that better plants can thrive.

9. Where seedings are made, use quick-growing plants like oats and rye that provide a cover quickly, to check erosion and to protect smaller and slower-growing plants, such as the perennial grasses.

10. Where sedimentation is likely to occur in the gully, use plants or seeds adapted to such conditions.

11. Plant legumes to gather nitrogen, which will aid the growth of grass.

12. Remember that gully soils are poor and will not support a dense stand, such as produced by heavy seeding. The tiny seedlings which must soon die are costly fertilizer.

13. Bank sloping is usually too expensive unless gullies can be used to advantage as parts of cultivated fields, or is necessary for the protection of other work.

14. If nature is left to do the bank sloping, protect the vegetation around the edge, and let it grow. It is best to plant grass such as Bermuda in the bottom of gullies.

15. Gullies on grazing land should usually be fenced unless it would be cheaper to stop grazing on the whole area until the gullies are healed over.

16. Keep out fire. The objective is the maximum of soil binding and water holding by vegetation dead or alive.

[1] Associate Range Examiner, Region 7.

CHIEF OF SERVICE RECEIVES DOCTOR OF LAWS DEGREE

Hugh Hammond Bennett on June 9 was awarded the honorary degree of Doctor of Laws by his alma mater, the University of North Carolina.

The recognition came as a result of Dr. Bennett's work as a writer, scientist, traveler, and explorer, and his contributions to the cause of soil conservation.

Dr. Bennett was born in North Carolina, owns a farm there today. He was graduated from the University in 1903, and shortly thereafter became a soil scientist in the Bureau of Soils. He served as a lieutenant in an engineering regiment during the World War.

Various important Government commissions carried him to the Canal Zone, Alaska, Honduras, Guatemala, Ecuador, Mexico, and Cuba.

His writings have ranged through popular magazine articles, reports, scientific papers, and textbooks. Among the familiar titles are *Soil Erosion a National Menace*, *The Soils of the United States*, *The Soils of Cuba*, *Possibilities for Para Rubber Production in Northern Tropical America*, and *Soils and Agriculture of the Southern States*.

It was in 1933 that Dr. Bennett was appointed to organize and direct a National program of erosion control under the Department of the Interior—a program which, under his able leadership, rapidly developed to the stature of the present Soil Conservation Service of the Department of Agriculture.

Sheet erosion in New Jersey coastal plain spinach field. Slope, about 2 percent.

CONTROLLING EROSION ON THE COASTAL PLAINS

By Alice Nichols

With a 1 percent limit on an A slope and serious erosion conditions to be found on fields with no more than a 3-percent gradient, the eastern coastal plain is offering some brand new problems in soil conservation. New Jersey's two new coastal plains projects are finding that measures which are effective elsewhere are often less so here, and that still other practices will not fit into the farming of the section.

Factors Peculiar to Area

Here are some of the factors which complicate the problem of erosion control:

1. High erosibility of soils—light loams and sandy loams.
2. Suitability of land to fruitgrowing and vegetable farming, forms of agriculture which leave the surface exposed during much of the year.
3. High production necessitated by high crop investments and high land values.
4. Impracticality of soil-binding through crop rotations, strip cropping and other methods practiced in general farming sections.
5. Lack of precedent for meeting existent conditions, since these are the first projects under way on the coastal plain.
6. A general belief that the erosion problem cannot be serious on these relatively flat lands.

New Devices

It looks as if some new techniques and new conservation terms are going to come out of New Jersey. Findings which are made there should have a wide application not only in New Jersey but also in coastal plains states to the south—Maryland, Delaware, Virginia, and the Carolinas—where similar erosion conditions and farming types exist.

Take the matter of controlling erosion in coastal plains orchards, where some of the most serious top soil losses occur. As a water conservation measure, fruit growers generally make a practice of clean cultivation. Though summer ground cover is increasing in favor—particularly in apple orchards where alternate middles are left in vegetation—many growers are more intent on immediate water

Strawberry plants silted over on 5 percent slope in southern New Jersey.

needs than on future soil needs. Most peach growers figure that vegetation would take too much water.

Mulch is one of the answers of the Soil Conservation Service, and its use has been written into several cooperative agreements. Mulches keep down weeds and thus do away with the need for cultivating. They give some protection, too, against the gullying which often starts from cuts made by the wheels of sprayers.

The erosion problem on the coastal plains was greatly augmented by the coming of the automobile. A number of years ago manure scows from New York City and Philadelphia supplied New Jersey farms with an abundance of cheap organic matter. This served to bind the sandy soils as well as to make them more absorptive. Though the use of winter cover crops, plowed under as green manures, is practiced extensively, the humus content of the coastal plain soils has been on the decrease, and high yields have been maintained only through use of increasing amounts of commercial fertilizer.

Adding Substance

Making the soil more absorptive and less erosible through adding organic matter, then, is one of the major soil conservation problems. This cannot be done through crop rotations because small grains and hay simply do not go with vegetable farming. This fact also makes ordinary strip cropping out of the question.

A practice which is taking hold, however, opens up possibilities for obtaining the beneficial effects which come from crop rotation and stripping. Some of the leading potato and vegetable growers are finding that they can well afford to give their land a periodic rest. In talking among themselves, some of the Soil Conservation Service men are calling this "alternation", and they are asking if it would not be feasible for growers to strip their cash crops with the land resting under cover.

Markets Govern

Fences are not used on vegetable farms, and acreages to be devoted to the various crops are determined by market prospects. Permanent buffer strips cannot easily be worked into this sort of a program because different crops require different spacing. This gives rise to the possibility of "shifting buffer strips" which would be left standing when the winter cover is plowed under.

No one measure will hold these sandy soils under the exposed types of farming they support. Considerable washing has been seen on cross-slope plantings and there is an alfalfa field on one general farm which has some gullying in it. Diversion terraces might have prevented these instances of erosion but their existence does show the need of applying every possible soil-conservation measure to every coastal plain farm.

THE PLACE OF THE FORESTER IN SOIL CONSERVATION

(Continued from p. 10)

his lumber, his posts, and his fuel, but he has become so accustomed to this that he has scarcely appreciated it. He has been more or less taking for granted what he gets from his woods, like the sunshine and rain. He has always had it, but has given it no attention and no credit. The burden of the soil conservation teaching is to get the farmer to see that he gets out of his farm very much in proportion to what he puts in. The farmer is, in this respect, in no different position than is the rest of the world. The woods on his farm is no exception to this universal rule. The forester's job is to show the farmer what to put into his woods and how to handle it in order to get the most out.

Appreciation of the Woods

First of all, then, the forester must be a crusader. He must make the farmer appreciate his woods so that he will keep it and take care of it. Chasing the woods about the farm is a poor way to get an income from it. He must appeal on the basis of economics, aesthetics, or sentiment, and after all, there is a lot of aesthetics and sentiment in both the woods and the farm. Dogwoods and redbud, June berry and laurel and rhododendron have their appeal, and so do 'coons and rabbits and quail and song birds; the pond down in the pasture, the old swimming hole, the mulberry tree, the papaws, persimmons and nut trees, are some of the things which make the old farm stand out not merely as a place of business and hard work, but as a home—there is sentiment as well as economics involved. The forester must make the farmer appreciate his woods by making them appear as they actually are, an integral and valuable part of the farm; capable of producing saleable products and as much in need of a definite plan of management as the cultivated crop portions of the farm. If he can succeed in doing this, the woods, which is the best agency to hold the soil, will not be destroyed by fire and grazing, or ruined by unintelligent cutting. The forester's job in soil conservation is definite and clear-cut. He not only has a place in soil conservation, he is indispensable.

CONTROL MEASURES MEET CHALLENGE OF HEAVY RAINS

(Continued from p. 7)

sponsored by the Service. A few of their notations, selected at random from the collection, are cited herewith.

Hereford, Texas.—Pasture contour-furrowed; 2 rows listed and 4 rows undisturbed. Penetration after 5.5-inch rainfall, 32 inches on furrowed pasture, 18 inches on unfurrowed adjoining pasture.

Memphis, Texas.—Sandy loam soil on farm cultivated and planted on contour, and terraced, wet past depth of 11 feet after approximately 6 inches of rain. On adjacent land, unterraced and farmed in straight rows, moisture to depth of only 7.5 feet.

Perryton, Texas.—Terraced loam soil has average moisture to depth of 32 inches while flat-cultivated land without terraces or contours has moisture to depth of but 21 inches, after 4 inches of rain in 10 days. On contour-furrowed pasture average moisture penetration 24 inches, as against 16 inches on untreated adjoining pastures.

Channing, Texas.—On land of 5-percent slope, terraced and contour-listed, moisture to depth of 52 inches, as compared with 28 inches on adjoining similar land not farmed on contour.

Clayton, New Mexico.—Following slow-falling rains totaling 1.6 inches during May, terraced and plowed field had moisture to depth of 27 inches, as contrasted to 15 inches on adjoining untreated fields.

Stratford, Texas.—Fine sandy loam, terraced, row-crop field receiving 5.31 inches of rain in 10 days showed moisture penetration to average depth of 5.5 feet. Similar adjoining land farmed in straight rows was wet to depth of 3.8 feet.

Springfield, Colo.—Rainfall 4.58 inches during May. Average moisture penetration, contour-listed land, 44 inches; land listed in straight rows, 35 inches.

Liberal, Kans.—Average moisture penetration on contour-furrowed pasture 45 inches, as compared with 17 inches on untreated pastures.

Vega, Texas.—Average depth of soil-moisture penetration on contour-listed land on S. C. S. project 2.15 feet following rains of 5.48 inches during last 10 days of May. On similar fields farmed in straight rows moisture penetrated to depth of 1.48 feet.

SWEET CLOVER ON THE BEAVER CREEK WATERSHED

By F. L. Higgins [1]

Sweet clover, only a few years ago considered a noxious weed, now occupies a high place among legumes for pasture and soil improvement. It starts growing early in the spring and produces a luxuriant verdure which provides excellent pasture for livestock. When plowed under for green manure, the roots and tops rot rapidly and crop yields respond.

On cooperating farms in the Beaver Creek watershed, near Caledonia, Minnesota, sweet clover plays an important role in contour strip cropping. It is especially well adapted to a two-year rotation, as follows: first year, grain with sweet clover; second year, corn. In this rotation, the sweet clover is seeded with the grain in the spring, and is left to make its growth in the fall after the grain is harvested and also during the following spring until about the first of May. The crop is then plowed under for corn. The strip that was in corn the previous year is thereupon seeded to grain and sweet clover.

The adjoining strip, which was seeded to grain and sweet clover the previous spring, has the sweet clover growth as a check on erosion until the strip which is being seeded to grain attains sufficient growth to bind the soil. This sweet clover is plowed under and the soil is prepared for corn. It is not advisable to plow under first-year sweet clover in the fall because of the likelihood of its coming up in the following crop. The rotation is illustrated below:

Strip 1—1937 in corn—1938 in grain and sweet clover seeded in April.

Strip 2—1937 in grain and sweet clover—1938 in sweet clover plowed May 1 for corn.

Turning under sweet clover as green manure every year will materially increase crop yields, and the humus supply of the soil will be maintained. This large amount of humus increases the capacity of the soil to hold and absorb rain water for crop growth. Rotations of corn and grain with sweet clover are now coming into general use, and corn yield has increased from 10 to 30 bushels per acre as a result. It should be pointed out, however, that since one of the crops is clean tilled, this rotation should not be practiced on excessively steep slopes.

High yields per acre mean profit per acre. For example, if it requires 25 bushels of corn to equal the

Sweet clover on farm near Greer, S. C. In this section it is a new crop, introduced by Soil Conservation Service. This stand was later plowed under and planted to corn.

[1] The author is assistant soil conservationist, Beaver Creek demonstration area, Caledonia, Minnesota.

cost of production, and if the soil is run down and can produce only that much, the farmer barely breaks even. If, on the other hand, he builds up his soil to a point where it will produce 60 bushels per acre, there will be a clear profit of 35 bushels with the same amount of work, provided there is no cost involved in building up the soil.

In a hilly country such as Southeastern Minnesota, there are many slopes of a gradient of from 15 to 25 percent which should never be in cultivated crops. The Soil Conservation Service recommends that these be devoted to hay or pasture. In strip cropping there are also some irregularly shaped pieces best adapted to alfalfa. Usually there is enough alfalfa produced on these steep slopes and odd pieces that the farmer does not need to grow hay on his strips. Under these conditions he cannot use the common 3-year rotation of corn-grain-sweet clover.

Experiments conducted at Kansas experiment stations show that the plowing under of six inches of sweet clover is equivalent to an application of 15 tons of manure per acre. The following tables show the fertility value of sweet clover, with amounts of nitrogen present in roots and tops one season after seeding, and total green weights per acre of tops and roots.

TABLE 1.—*Nitrogen present—pounds per acre*

Time of year	Top	Roots
April 10	15	162
April 25	63	103
May 15	128	75

TABLE 2.—*Total pounds per acre—green weight*

Time of year	Top	Roots
April 10	430	3,600
April 25	1,510	2,300
May 15	4,210	2,030

Table 1 shows that practically the same amount of nitrogen is present in the crop on April 10 as on April 25 and May 15. The food reserves are stored in the large tap root system in the fall. In the spring the early top growth is fed from these food reserves in the roots and there is simply a transfer of the nitrogen from the roots to the top. On the later dates, the data shows an increase of the nitrogen and total green weight in the tops and a corresponding decrease in the nitrogen and total green weight of the roots. Another point in favor of plowing under the crop at an earlier date is that, to produce this top growth, an equivalent of 10 inches of rainfall is required.

Before seeding sweet clover, the soil should be tested for acidity, and if necessary, lime should be applied. In the Beaver Creek watershed, most of the land requires an application of from 1½ to 2½ tons per acre. Sweet clover seed should be inoculated and seeded at the rate of 15 pounds per acre. Alfalfa requires the same amount of seed per acre. A firm seedbed is essential for a good stand, and a corrugated cultipacker can very often be used to good advantage in making the soil more compact both before and after seeding. These operations should be performed on the contour.

Sweet clover can also be used to great advantage in the rejuvenation of permanent pastures which have become low-yielding through thinning of the stand, poor soil, weed infestation, or acid condition of the soil. A large number of pastures at the present time are not as productive as they should be. They can be greatly improved by liming and fertilizing the soil and the seeding of sweet clover, not only from the standpoint of furnishing pasture, but also as a repellent to the white grubs of the June bug.

Pasture Demonstrations

In the soil-conservation program, it is planned to set up a number of demonstrations of permanent pasture improvements by liming the soil and thickening the pasture stand through the seeding of sweet clover. In some cases the old sod will be disked or spring-toothed, lime added, and sweet clover added at the rate of 10 pounds per acre. In other cases, instead of seeding sweet clover alone, a pasture mixture will be seeded consisting of 4 pounds of sweet clover, 4 pounds of alfalfa, 4 pounds of bluegrass, 2 pounds of brome, 2 pounds of red top, 2 pounds of alsike, and 2 pounds of timothy.

The introduction of alfalfa and sweet clover also helps in the control of the white grub which does so much damage to bluegrass pastures. For some reason, the June beetles do not like to lay their eggs where alfalfa and sweet clover are present. Recent experiments by the Wisconsin experiment station, have shown practically complete control of white grubs by seeding alfalfa and sweet clover in the pasture.

As a hay crop, sweet clover is not so good as alfalfa or red clover and is seldom used for hay in regions where alfalfa and red clover can be grown.

Slope of Italian brook regulated in 1932.

NOTES ON EROSION WORK IN FAR-AWAY ITALY

By Albert Chiera[1]

Erosion authorities in Italy, as elsewhere, are agreed as to the importance of vegetative cover. Notes which I have made in connection with my translations of Italian works, may prove of interest to readers of Soil Conservation.

In A. Serpieri's book the laws on integral land reclamation may be summed up as follows:

(1) By land conservation is meant the prevention of land destruction by carelessness on the part of landowners, or by improper methods of land exploitation, which, under penalty of law, the State will not tolerate.

(2) By land reclamation is meant those supplementary works required for restorative vegetation to become reestablished over denuded areas, particularly mountain slopes.

[1] The author is translator and research assistant, Soil Conservation Service.

Conservation works required to preserve the land in Italy must be carried out by landowners at their own expense; reclamation works, being more costly, are subsidized by the State, in some cases to the extent of 90 percent of the cost.

Let us now see how this work is carried out and the methods used.

Since Italy is a mountainous country, runoff waters mounting into torrents from the melting of snow and ice in the Alps and Apennines must be first be checked before any work of reforestation is attempted. Unfortunately, vegetation can only grow up to a certain altitude, and mountain torrents must first be controlled by large dams, which decrease in size as vegetation takes up its task of binding soil and restraining runoff waters.

Description of Dams

The steps that must be followed and the kind of dams best suited, according to the topography of the land, is intelligently described by C. Valentini in his book *Control of Torrents and Mountain Basins.*

On those slopes where vegetation is being assisted by supplementary small dams, denuded mountain slopes, broken up by gullies, are smoothed out. Supplementary works of fascines and wattles are then constructed on the contour of the slope, to stabilize it and to prevent drainage materials from rolling downhill before plants are sown or planted. In other cases large bench terraces (*gradoni*) are made to scale the mountain sides, and over these plants are sown or transplanted from the nurseries.

Ground Prepared for Vegetation

It might be of interest to note here, that according to E. Ferreri's *Woods and Pastures*, much of the failure of vegetation to grow on denuded slopes is due to failure to prepare the ground with temporary grasses which would have shielded the seeded plantlets from intense heat in summer and frost in winter. Another cause is found in the transplanting of young forest plants, grown more or less under ideal conditions in the nursery, to the mountain where severe climatic conditions prevail, causing 50 percent of the plants to die.

The author emphasizes and illustrates the necessity of growing plants in a nursery on a mountain resembling the climatic conditions of the place to which they are later to be transplanted, so that they may be well acclimated to resist the fury of the elements at high altitudes.

Regulating Streams

Once a forest is established and drainage of materials prevented, states C. Valentini, it is then possible to think of regulating streams and rivers.

A. Viappiani, in his book *Practical Fluvial Hydraulics*, emphasizes the importance of regulating the flow of a stream or river course. Here, also, crumbling must be prevented by smoothing out the banks, stabilizing them with grasses, shrubs, and trees, or protecting them by artificial means. Among the latter are repealing spurs, galvanized iron cages filled with stones, placed at strategic points, or the complete revetment of banks by stones; in short, artificial methods are many, all aiming to avoid depositation of eroded materials that either go to choke up the flow of a watercourse or raise its bed, either of which causes an overflow. In other cases, if the sediment is carried away, it may later deposit in reservoirs, resulting in silting.

In conclusion, the soil on the mountain, field, or banks of streams or rivers must be conserved by vegetation or assisted by inert materials if the land and water resources of the nation are to be preserved.

When this is not done, reclamation works must be undertaken at a much larger cost. Difficulties are then multiplied, ultimate success made dubious. How simpler it is, when possible, to prevent silting of a watercourse by binding the soil particles with vegetation than to sieve the water to remove them by all sorts of man-made contraptions! The building up of lowlands by sedimentation of waters charged with sediment is far more complicated than the preventing of destruction of good lands. This phase of the problem is very astutely discussed by A. Fanti in his book *The Technique and Practice of Reclamations.*

An example of Italian reforestation for flood and erosion control.

MEETING NOTE

Fourth International Grassland Congress, July 15–18, 1937, Aberystwyth, Great Britain. Papers will include the following subjects: 1. Ecology, pasture management, including erosion control; 2. Seed mixtures, including lucerne for grazing, legumes for use in poor pastures; 3. Plant breeding, genetics and seed production; 4. Manures and fertilizers; 5. Fodder conservation; 6. Grassland economics.

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

A contribution from the Soil Conservation Service Library

WEEDS. By W. C. Muenscher. 1935.

In cultivated lands weeds compete with crop plants for water, nutrients, and light. Furthermore, they are usually better adapted to obtain the larger share of whatever water is available as well as fertilizers supplied so that, unless they are destroyed, they soon outgrow the crops and shade them. Likewise, many common weeds act as hosts for fungi, bacteria, and mosaics, and insect pests which are transferred to crop plants. Examples are the common quack-grass (*Agropyron repens*) which harbors the black stem-rust of wheat, oats, and barley; and the burdock borer which infests corn-fields. In many places, such as arid regions where irrigation is practiced, weeds find favorable conditions for growth along the canals and laterals through which water is supplied to crops, thus interfering seriously with proper distribution of moisture.

On the other hand, those plants which are called weeds, when properly utilized, may prove beneficial. When plowed under or returned to the soil in some other way, weeds add humus and nutrients by returning to the soil nitrogen and ash constituents. In regions where soil blowing is common, or on sloping soils with sudden heavy downpours, weeds often form useful cover. Some weeds furnish forage for animals when more palatable plants are scarce; and millions of birds subsist on seeds which cling to weed stocks throughout winter months. The sour dock, lambs-quarter, milkweed, and several other common weeds are edible by humans; and there exists, too, a long list of common weeds that have medicinal properties and are used in the preparation of medicines and drugs.

With the knowledge that some weeds are harmful while others are beneficial, depending to some extent upon environment, it becomes obvious that information concerning the identification and control of weeds is important to the soil conservationist as well as to the farmer.

Part I of this book is devoted to a consideration of those characteristics and habits of weeds by which they affect other plants or interfere with man's activities, and also to the methods employed for their eradication or control. In the chapter bearing the title "Weeds of Special Habitats", weeds are classified according to persistent growth in lawns and turfs, pasture lands, hay fields, and meadows, cultivated fields and gardens, grain fields, cranberry bogs, and rice fields. These weeds of special habitats are the most troublesome and noxious of all, since their life cycles correspond so closely to those of the useful plants with which they grow and they tend to increased abundance and vigor as long as those crop plants are grown. The secret of the control of weeds of special crops is a system of rotation—change of habitat.

The control of a weed is a many-sided study. In the first place it is necessary to understand the habits, habitat, and distribution of the species, and secondly, to have knowledge of the various methods of weed-spread prevention, complete eradication, or control. The author discusses twenty-seven methods of weed control, and in addition, presents a complete chapter on the subject of control by chemicals.

Part II, comprising some 438 pages, forms a weed manual, with key to groups and species, and descriptions and data concerning names, duration, reproduction, dissemination, habitat, range, source, recognition, and control of the commonest weeds of the northern United States and Canada. Particular emphasis is given to identification and control.

In the manual the weeds are arranged in alphabetical order, under their scientific names, by families. The names used for species are those employed in botanical manuals and floras, and where there are differences in usage synonyms are included. The statements of distribution for the various species are not necessarily their botanical ranges, but the approximate area or areas in which they are known to occur as weeds.

The book contains 123 illustrations of weeds, most of which are drawings from live plants.

HUMUS: ORIGIN, CHEMICAL COMPOSITION, AND IMPORTANCE IN NATURE. By Selman A. Waksman. 1936.

In this, his latest work, the author who is professor of soil microbiology at Rutgers, and microbiologist, New Jersey Agricultural Experiment Station, tells the story of humus, its origin from plant and animal residues, its chemical composition, its physical properties, its importance in nature—especially in soil processes and in plant growth—and finally its decomposition. Humus is here treated as a natural body, produced universally in nature wherever plant or animal residues are undergoing decomposition; and here it is recognized that the primary agents in the formation and transformation of humus are the microorganisms.

In Part A of his book Professor Waksman treats of the chemical nature of humus, its formation, methods of determination in soils and in composts, and its role in plant nutrition.

Part B is an extensive thesis on the origin of humus, including a study of the isolation of chemical compounds of plant and animal residues and of the chemical nature of humus as a whole; of humus formation in composts and manures, in forest and heath soils, in mineral soils (field, grassland, garden, and orchard), in peat and in coal, and in rivers, lakes, and seas.

Part C deals with the decomposition of humus, involving the nature of the residues and the conditions under which decomposition takes place. In this section of his book, the author has included, along with the technical treatment of his subject much information of a practical nature. Herein is a discussion of specific substances in humus which are injurious or favorable to the growth of plants, animals, and microorganisms; a chapter on the agricultural utilization of humus; and, finally, a discussion of soil humus and the science of pedology.

The appendix contains outlines of five distinct methods for determining total humus in soils, peats, and composts.

Important data assembled in table form; 68-page bibliography; author and subject indexes.

APPLIED SILVICULTURE IN THE UNITED STATES. By R. H. Westveld. Ann Arbor. 1935.

Presents silvicultural methods applicable to timber stands that are managed primarily for the production of forest products. Gives a systematic study of climatic and physiographic features, forest vegetation, method of past treatment, natural and introduced animals, insects, diseases, and economic conditions of the following forest regions: Northwest spruce-hardwoods; New England white pine; oak; Allegheny hardwoods-pine-hemlock; Southern Appalachian; Southern pine; Central hardwoods; Lake States; Douglas fir; Northern Rocky Mountain; lodgepole pine; Southwest ponderosa pine; California pine; Northwest ponderosa pine; Black Hills ponderosa pine; Redwood; Southeastern Alaska.

References at ends of chapters. Appendix contains names of trees and their scientific equivalents. Map of forest regions of the United States. 86 photographs. Index.

PUBLIC LAND SURVEYS; HISTORY, INSTRUCTIONS, METHODS. By Lowell O. Stewart. Ames. 1935.

Traces the development of technical aspects of public land surveys. Gives instructions and field technique in the RectangularSystem of Surveying. Bibliography. Index.

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

A contribution from the Soil Conservation Service Library

WEED SEEDS. By Emil Korsmo. Oslo. 1935.

Professor Korsmo's manual of weed seeds is presented in three languages—Norwegian, German, and English. It includes descriptions of seeds and infructescence of 306 different species of weeds, all of which are shown in plates, with special care as to accuracy of color and size. The species are chiefly those to be found in Europe and North America. The book was compiled specifically as a guide for those directly concerned with the inspection of agricultural seed materials and includes, therefore, a selection of seeds from those species of weeds which are frequently found as impurities in seed materials. For example, seeds of *Plantago aristata* are present in clover and grass grown in North America; and *Bifora radians* commonly is to be found in Hungarian vetches. The collection is thus made useful in the identification of species which may be spread through the sale of seeds of various grains, grasses, and legumes.

In the descriptions of the seeds an attempt has been made to give figures for weights, in grams, of 1,000 seeds, and the greatest length and width of seeds in millimeters. A system of plate letter-reference is used, thus simplifying use of both plates and text. Distribution notations are given for all species.

At the end of the book is to be found an index of all included species of weeds, arranged alphabetically according to their latin names with an addition of the common names, in eleven different languages, i. e., American, Danish, English, French, Dutch, Italian, Canadian, Norwegian, Russian, Swedish, and German.

DESIGN OF CONCRETE STRUCTURES. By Leonard C. Urquhart and Charles E. O'Rourke. 1935.

In this revision most of the material has been rewritten to include the latest and best practice in plain and reinforced concrete design. Modern methods of design and control of concrete mixtures are described in detail. Contains chapters on plain concrete; general properties of reinforced concrete; beams and slabs; columns; bending and axial stress; stresses in continuous beams and building frames; foundations; reinforced concrete buildings; retaining walls; arches; slab, beam, and girder bridges.

THE TRANSLOCATION OF SOLUTES IN PLANTS. By Prof. Otis F. Curtis. New York and London. 1935.

A monograph for the plant physiologist, including a discussion of the historical side of the subject of translocation in plants. Contains the author's views on the particular functions of the different channels of transport in higher plants, and a survey of the investigations of Mason and Maskell on translocation in the cotton plant. Diagrams.

AMERICAN PLANNING AND CIVIC ANNUAL. Edited by Harlean James. American Planning and Civic Association. 1935. 356 pages.

The orderly development of a plan for common good makes a great and inspiring subject. This compilation contains articles by 81 authors and covers practically every phase of the national program for conservation. The Secretary of Agriculture, writing on rural-land problems, stresses the need for a permanent land-settlement policy in order to get a million farm families off the relief rolls. In Mr. Wallace's opinion this policy will involve land- and water-use laws; crop-control regulations; and the cooperation of farmer, grazer, forester, lumberman, wild-life conservationist, flood-control specialist, engineer, and land-retirement agency, for soil conservation.

In a brief résumé of soil conservation projects H. H. Bennett gives arresting figures on erosion damage in the United States gleaned from surveys made by his Service.

In the book are some specially fine monographs on the protection of wildlife. One, by Dr. Darling, former Chief of the Biological Survey, stresses most forcefully the one great need for animal and bird life, land where these creatures may have their home and preserve their species in proper habitat and interrelationships. Dr. Darling's famous cartoon is inserted, picturing a few hapless animals marooned by the gales of misfortune on a tiny island and staring with wild eyes into the tragic future. What person with imagination can study this cartoon without feeling a deep pity for the unfortunate wild creatures of our country? The pileated woodpecker, the grizzly, the wild turkey and the otter, the mountain goat and the wapiti—without national human planning for their preservation and their refuge, swift extinction will be the fate of these and many other species.

As set forth by the authors, the special function of national planning involves three types of service. The first of these is a cooperation of the multiplicity of ideas, activities, interests, needs, and specialties which the people of any community possess, apply, and press. A second necessary element is that of foreseeing the future as it links with the present and the past. The third factor—gathering data, studying, it and sorting out the good from the bad—is of the deepest importance to the methods of what we call planning.

In the third section of this annual there are several papers on the process of planning which are most enlightening to the layman. One concludes that a plan is as good as the directing intelligence under which it is made, and that the importance of the intelligence cannot be overweighed. The illustrations, 36 in all, serve to emphasize and clarify the subject matter. The book is well assembled, with the purposes of the American Planning and Civic Association clearly set forth on a page following the contents, an index, and a contributing-author column.

Having thoughtfully read this book, one cannot but appreciate to the uttermost the tragic danger in wasting something that is valuable to civilization—if for no other reason than that, in the far distant future, the students of antiquity may not malign our era.

(This book is available in our library for the usual short-period loans.)

U. S. GOVERNMENT PRINTING OFFICE: 1936

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Compiled by Mrs. Etta G. Rogers, Publication Unit

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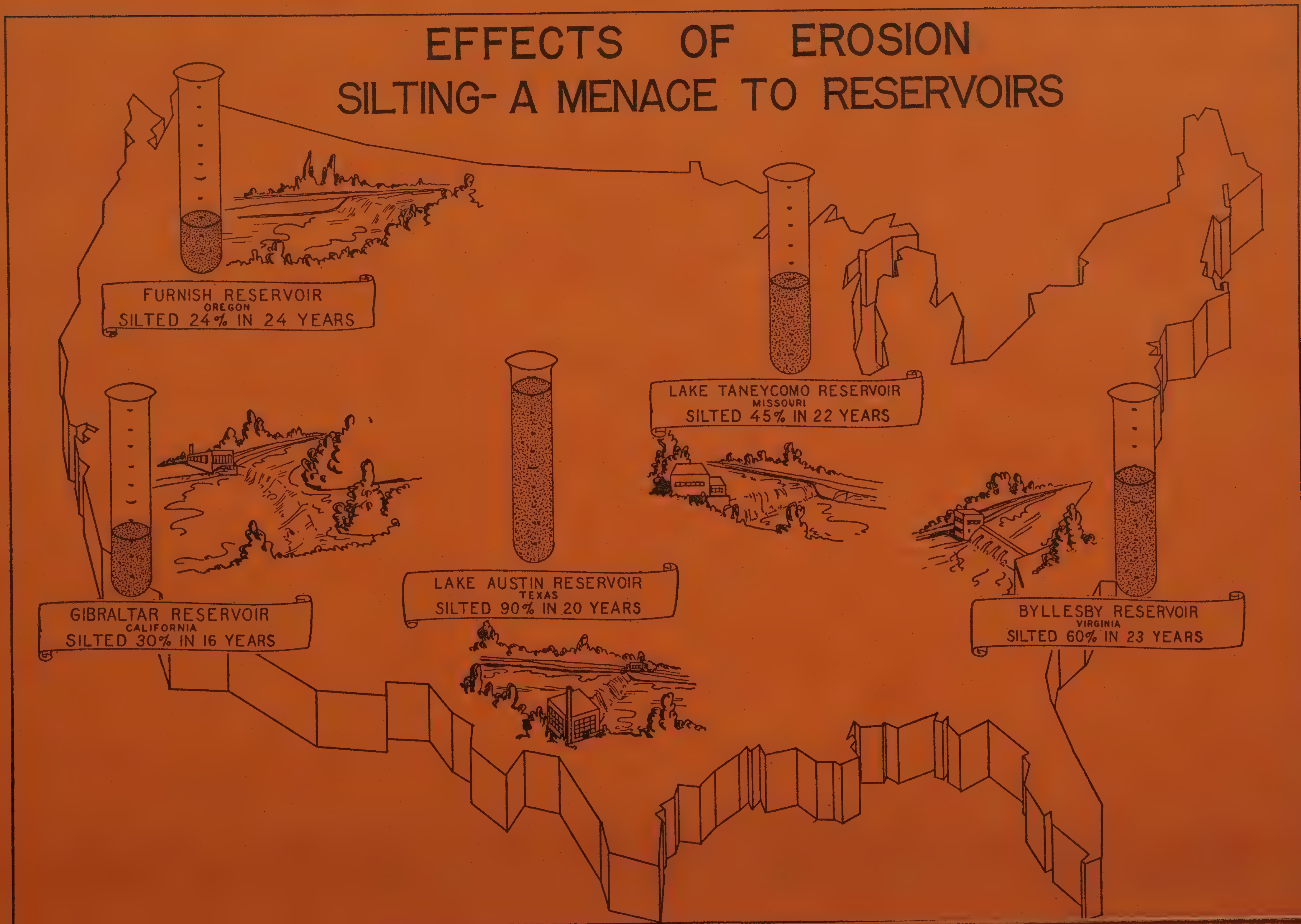
EFFECTS OF EROSION
SILTING- A MENACE TO RESERVOIRS
FURNISH RESERVOIR
OREGON
SILTED 24% IN 24 YEARS
LAKE TANEYCOMO RESERVOIR
MISSOURI
SILTED 45% IN 22 YEARS
GIBRALTAR RESERVOIR
CALIFORNIA
SILTED 30% IN 16 YEARS
LAKE AUSTIN RESERVOIR
TEXAS
SILTED 90% IN 20 YEARS
BYLLESBY RESERVOIR
VIRGINIA
SILTED 60% IN 23 YEARS

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

AUGUST 1936

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Cover design suggested by original photograph

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FOLLOWING PARALLEL PATHWAYS TO EROSION CONTROL

By Guy C. Fuller[1]

Within a brief 3 years strip cropping has emerged from the shuffle of old and new ideas and become recognized as one of the most efficient and practical means of controlling erosion. Particularly commending it is the fact that it may be applied in every region of the United States.

Strip cropping is being recommended because of its simplicity, its flexibility, and, above all, its economic value to the farmer. It is simple because it involves only a rearrangement of the crops usually grown. It is flexible because of the many ways in which it may be used. The economic value of strip cropping may best be measured by the way in which it is being adopted by the farmers. Large numbers of them are coming to realize that it is indispensable so long as they are dependent upon the soil for their existence.

A Pat Comparison

Strip cropping may be compared with the rations of livestock. The dairyman, by mixing in a little different proportion, the ingredients of his cows' diet, will be rewarded by increased profit. The hog raiser may alter his feeds similarly and be well paid in the form of more economical gains. If this is true of livestock, it is even more true of crops, and the farmer may often increase his net return by the adoption of a strip cropping program.

[1] The author is associate agronomist, Soil Conservation Service.

The crop farmer looks toward his soil rather than his livestock for a living. In some areas he depends upon both, but when he realizes the importance of balancing his cropping system as the livestock feeder balances his rations, he will be on his way toward obtaining the maximum net return.

Management Counts

Not only the diet, but the manner of feeding, is important. Good, prosperous livestock farmers realize that great care in methods of feeding, such as clean feed lots or pastures, proper time of feeding, and thoughtfully adjusted amounts of feed with good clean water are contributing factors toward economical meat production. When farmers exercise equal care in the selection of crops, seed-bed preparation, time of seeding, rates and methods of seeding, greater net returns will be realized.

Strip cropping, in its general application, refers to the production of regular farm crops in relatively long variable-width strips, placed crosswise of the line of slope and approximately on the contour.

Crop Groupings

In all regions, regularly grown crops comprise a list too long to enumerate, but we do find it possible to group them, broadly, in two categories: (1) Close-

(See pictures on pp. 30-31, Strip Cropping from Coast to Coast)

growing crops, such as wheat, oats, barley, rye, and hay crops; (2) row crops or clean-tilled crops, such as corn, cotton, tobacco, potatoes.

Close-growing crops are regarded as being particularly desirable because—

1. They reduce the speed of flowing water.
2. By reducing the speed of water, cutting action is held to a minimum and silt or soil particles will be deposited or dropped.
3. The slower the movement of water, the greater the absorption by soil.
4. Close-growing crops act as spreaders, preventing concentration.
5. They permit interception and dispersal of raindrops, which checks the beating action of heavy rains. They produce a shading effect, which reduces evaporation during periods of drought.

Crop Combinations

In direct contrast, row or clean-tilled crops afford the least resistance to erosion, making it necessary to use the two types of crops in proper combinations in order to attain desired results.

By alternating strips of close-growing crops with row or clean-tilled crops down a long gentle slope, soil and moisture losses are reduced to a minimum.

Water falling upon the clean-cultivated land will meet with little resistance and will gain momentum as it passes down the slope; therefore, the practice is recommended of placing the crops in variable-width strips crosswise of the line of slope—the width of each strip being determined by the percent of slope, the type of soil, and the crops to be grown. Such a practice is simple, inexpensive, and widely applicable.

Cover for the Land

In view of the data obtained and recognized value of a vegetative cover in a strip-crop system of farming, the ration will not be balanced unless a vegetative cover is provided for the land at all times. Here again we may refer to the list of crops possible to be grown in any given region. In the Southeast winter peas broadcast in a clean-tilled crop, such as cotton, late in the summer will provide an excellent cover during the winter. In other areas, rye, winter wheat, or vetch may be used but wherever possible legumes should receive first consideration.

The addition of more crop residue will materially aid in the balancing of this ration. When worked into the surface soil, residues should not be pulverized or completely broken down into small particles which are easily carried away by moving water. Coarse particles of crop residue, together with rough-tillage practices or seed-bed preparation, will conserve soil and moisture, acting in a manner comparable with that of close-growing crops. The cover crop or crop residue will add organic matter to the soil when plowed under or worked into the soil. Legumes plowed under whenever possible as green manure, will materially improve the soil and conserve moisture.

In other areas, where the land is more broken with varying degrees of slope, and in the more humid regions the construction of terraces on the contour, together with strip cropping, has proved to be an effective practice. Moreover, planting, cultivating, and harvesting on the contour is showing itself to be a cost-cutter in horse- and mule-power and machine operation, because it takes less energy to go around a hill than it does to go up and down a hill.

No doubt modifications of strip cropping will be forthcoming as its use is extended and farmers become more familiar with its operations. But of all the practices, old and new, strip cropping has emerged an important keystone in the arch of erosion control. This is because it is simple, flexible, economical, and widely applicable.

TO CONTROL RUN-OFF WATERS ON COLLEGE FARM

Construction of a complete water-disposal system on approximately 200 acres of Clemson College farm will begin soon as a joint undertaking of the college and Soil Conservation Service.

C. C. C. camp 14 in Pickens County, S. C., will cooperate in developing the project to curb erosion on the college farm.

The camp engineer will supervise the running of terrace lines for Nichols-type terraces. Technical workers of the camp are to plan terrace outlets and channels to dispose of run-off water.

As soon as the plans are completed the college will construct terraces under the supervision of C. S. Patrick, college farm superintendent, R. A. McGinty, acting director of research at Clemson, has announced.

Camp enrollees will build the terrace outlets and channels. Bermuda sod is to be used in the open field and masonry structures in woodland to protect the outlet channels against gullying.

A Practical Demonstration

All of the terraces will be constructed in accordance with specifications which have been worked out for South Carolina by the Soil Conservation Service and the Extension Service.

When completed the water disposal system will give thousands of South Carolina farmers who visit the farm each year an opportunity to observe improved practices for disposing of run-off water from cultivated fields.

Photographers that can climb like firemen and bring down picture prizes not available when they keep both feet on the ground make a real contribution to the improvement of Soil Conservation Service pictures.

A little elevation eliminates undesirable foreground and extends the range to show a coordinated system of erosion-control measures applied over large fields or an entire farm.

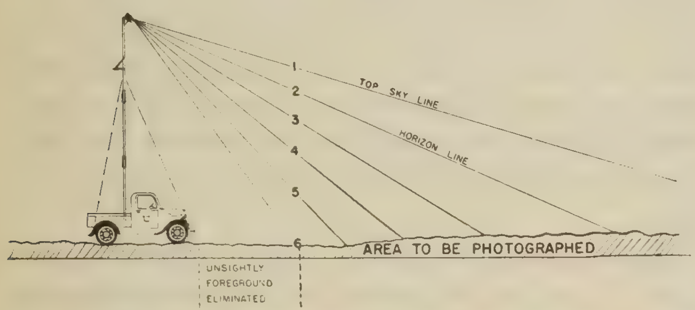


Figure 1.—A correct angle for photographing terraced fields or strip-crop areas. Clear focus, with unobstructed vision, is assured.

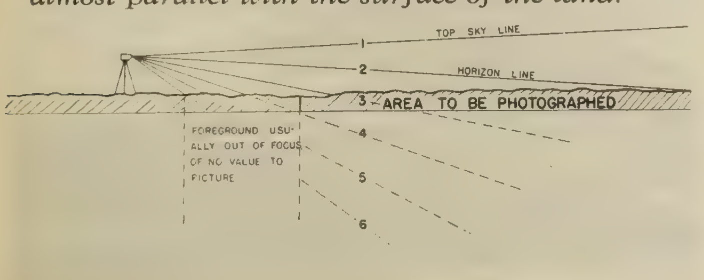
Assuming that the photographer won't risk his neck and camera by climbing trees to attain desired elevation, two major items of equipment are necessary for the job—a light pick-up truck, and a ladder properly mounted and anchored on the truck. The ladder must fold down to a height of 11 feet to pass under viaducts.

A Ladder on a Truck

Orin S. Welch, regional photographer in the Southeast, devised the ladder mounted on the truck shown in the accompanying illustrations.

Figures 1 and 2 show the desirability of taking pictures of erosion-control measures from an elevated position. Elevation provides the correct angle for taking photographs of broad areas, entire terraced fields, or strip crops. In this manner objects to be photographed are brought within the range of vision. Figure 2 shows the difficulty encountered in attempting to photograph large areas with the camera at tripod height. Unsightly foreground detracts from the artistic value of the resulting photograph and the scope of the picture is reduced greatly.

Figure 2.—An incorrect angle for photographing terraced fields or strip-crop areas. The camera is set to the same horizon line as in the other diagram, but due to its low position this line travels almost parallel with the surface of the land.



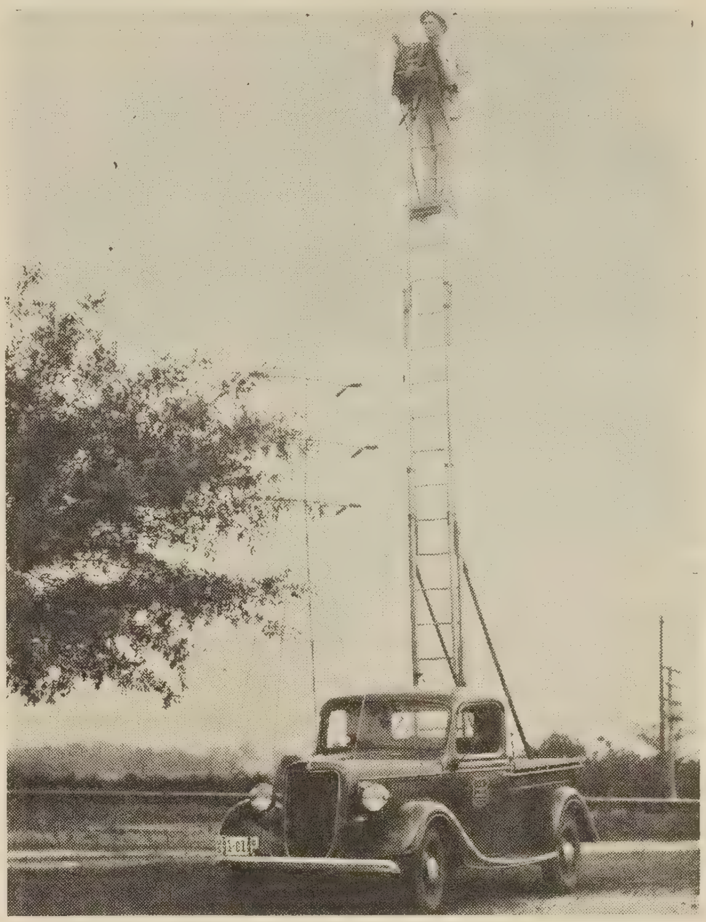


Figure 3.—Taking the picture.

Cables Stabilize Ladder

Figure 3 shows the truck and ladder equipment in operating position. Six wire cables are used to stabilize the ladder. Two are attached to the front bumper, two to the rear end of the truck body, and one to each side of the body. The cables are permanently attached to the ladder. When the ladder is folded down they are packed inside the truck body.

When the photographer is ready to drive to the next scene, he folds the ladder down. Figure 4 shows the method of raising and lowering with a piece of 2-inch gas pipe and crank to which wire cables are connected with the ladder. Turning the crank raises or lowers the ladder.

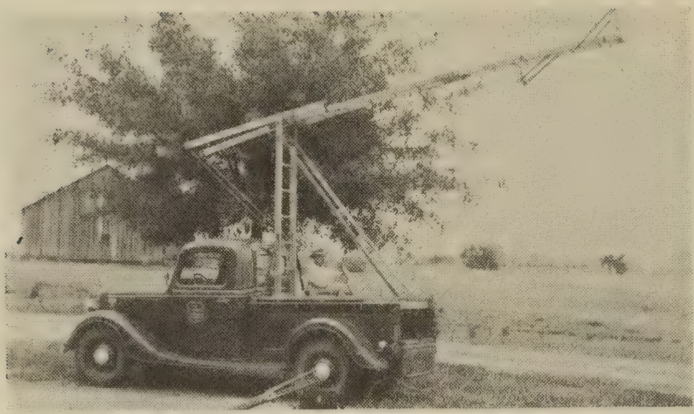


Figure 4.—Raising or lowering the ladder.

In figure 5 the ladder is being folded into the position as shown in figure 6, the position for travel to the next job. When moving any considerable distance the ladder sections may be dismantled easily and carried in the body of the truck. The ladder as shown in figure 6 clears less than 11 feet, the maximum permissible height for trucks moving on the highways.

A limited number of sets of specifications and blueprints for the construction of the ladder are available upon application to G. A. Barnes, in charge of the Section of Information. The total cost of all materials is less than $25. It can be constructed by two good workmen in 1 day. The job explained in this article was supervised by R. L. Stribling, chief warehouse mechanic, at Spartanburg, S. C.

Breadth Increased

Elevation brings into view a broader and deeper area. The breadth of the area may be increased still more by using the 5 by 7 camera now in use by the Soil Conservation Service, as a substitute for a circuit camera.

From the photographic ladder or from the ground panoramic views may be taken with this regular equipment.

To do this job care must be exercised in focusing the camera, with the tripod perfectly level. Determine the breadth of the area by swinging the camera, observing the scene as it appears on the ground glass.

Select the first position for the camera; mark the side of the tripod base to correspond with a designated point on the camera frame. Next look through the ground glass and move the camera to the second position allowing a small margin of the scene to overlap. About one-fourth inch is sufficient. Mark the point on the tripod to correspond with the point on the camera frame as before. The distance to be marked off for the third and subsequent scenes has now been determined. Always tighten the tripod screw before making an exposure and loosen it slightly before moving the camera to the next position.

Arrange the pivot of the camera to place it in position directly below the lens. This aids in obtaining a more perfect alignment for matching scenes in the foreground.

When to Take Pictures

The best views are made in early morning or late afternoon sunlight during the summer months. The midday sun gives too much overhead light, too much glare, not enough shadow. This is particularly true when photographing terraced fields or strip crops. Deep gullies or steep hillsides are subjects that can best be photographed when the sun is directly overhead.

Avoid direct back or front lighting whenever possible. If the lens is properly shaded a front light is preferable to light from the rear provided there is no better choice.

Panoramic Views

In making panoramic views the camera faces a different light angle from each position. A most careful study of this phase is essential if successful results are to be obtained. Each exposure of the panoramic view must be timed the same, with the diaphragm adjusted accordingly, regardless of lighting effects on the landscape.

If the camera is properly focused and all set screws tightened before making the first exposure, it is unnecessary to make further adjustments other than tightening the tripod screw and operating the shutter to complete the panorama.

Film packs are preferable for making panoramic views. They are compact and the job requires less time, an important feature when the ladder is being used.

(Continued on p. 35)

Figure 5.—Folding the ladder into position.

AN EXPERIENCE WITH BLACK LOCUSTS

A Muskingum County, Ohio, farmer, John Newell, knows from personal experience the value of black-locust trees in the control of soil erosion. Not only have black locusts reclaimed gullied areas on his farm but for a quarter of a century they have yielded him a profit from the sale of posts.

Forty-five years ago there was a natural black-locust grove on the Newell place, then owned by his father. The grove was cleared and the land was farmed for many years. At the time of clearing, the Newell boys planted "a couple of armfulls of locust sprouts" near the bottom of some bad gullies. They were planted in typical Ohio Muskingum silt loam and the area had no special preparation. The planting was done against the advice of the elder Mr. Newell, who didn't expect them to grow.

But they did grow and from the original plantings spread completely across the gullied area. From this original planting John Newell has been cutting posts for the last quarter century. He has sold posts every year for from 25 cents to 45 cents each. Two years ago Newell cut 165 posts and netted $41.25 for his trouble. During the most recent winter he cut a similar number of posts from three aged trees.

"They grow fast", Newell said, "and the nice part of it is they stop the gully washing. The first thing to grow is weeds, then the leaf litter begins to cover the ground. Then it isn't long until bluegrass comes in."

Foresters who have visited Newell's woodlands also note that other species of trees—having greater value from the standpoint of timber production—are getting a start.

Indication of extent of extreme erosion on the Newell farm in January 1935. Before being planted to black locust sprouts, this area was eroded down to the subsoil and gullies had formed from 3 to 6 feet deep. At the time this picture was made the locusts had taken root in the bottoms of the gullies and were spreading to the ridges between. Leaf litter and grass were serving to prevent further excessive losses of soil.

By May 1936 Canadian bluegrass had voluntarily covered the area, definitely controlling erosion where raw gullies had formerly existed.

LESPEDEZA'S VALUE SHOWN BY EXPERIMENT

The value of rotations is illustrated by results of experiments with cotton and lespedeza conducted by the Soil Conservation Service in cooperation with the South Carolina Experiment Station. Results were obtained from 33 plots scattered over 11 farms.

Each plot was divided into two equal parts. One part was sown to lespedeza and the other half planted to cotton. The following spring lespedeza was turned under and the entire area planted to cotton. All of the plots received the same tillage and fertilizer treatment.

Erosion Reduced

Lespedeza cut down erosion losses. Every thousand gallons of run-off water from terraces in the cotton land washed away 8.3 pounds of soil, whereas the same amount of water from the lespedeza land carried 2.5 pounds, or less than one-third as much soil. Furthermore the total run-off from the cotton land amounted to more than 17 percent of the total rainfall, while on the lespedeza all but 10 percent of the total rainfall was absorbed into the soil where it fell.

Seed cotton yields on the lespedeza land averaged 939 pounds per acre. Where cotton followed cotton the yield averaged 583 pounds. Lespedeza increased the yield, therefore, an average of 356 pounds per acre or 61 percent.

Interpreting these results, scientists conducting the experiments found that the cotton land lost an average of 17 tons of soil while the area in lespedeza lost slightly more than 1 ton per acre.

GREEN ROADSIDES MAKE STABLE HIGHWAYS

By George W. Hood [1]

Erosion control on highways means, first of all, grades where vegetation will grow. Grasses take kindly to easy, continuous slopes. And on such slopes power mowers may be used and maintenance costs held down thereby.

Trees are in order on many steeper slopes and banks. All slopes should be gently rounded, and the waterways should be made wide and shallow.

Grasses Prevent Cutting

Cutting does not usually occur where grasses are firmly established and where the waterways are wide so that the water is spread out in a thin sheet.

When we discuss vegetation, we naturally include alfalfa and other vegetation not of the true grass type which, in addition to suitable grass mixtures, often make an excellent ground cover.

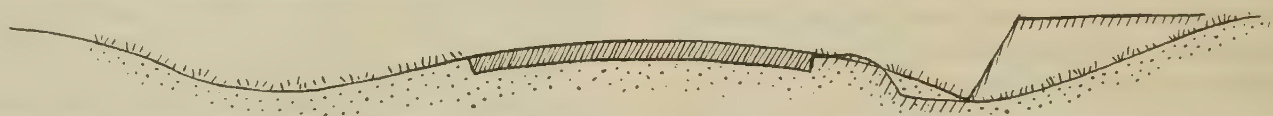
Deep cuts and high banks call for the use of shrubs or woody vines, with opportunity now and then for the planting of trees as a further measure.

Locating Inlet Culverts

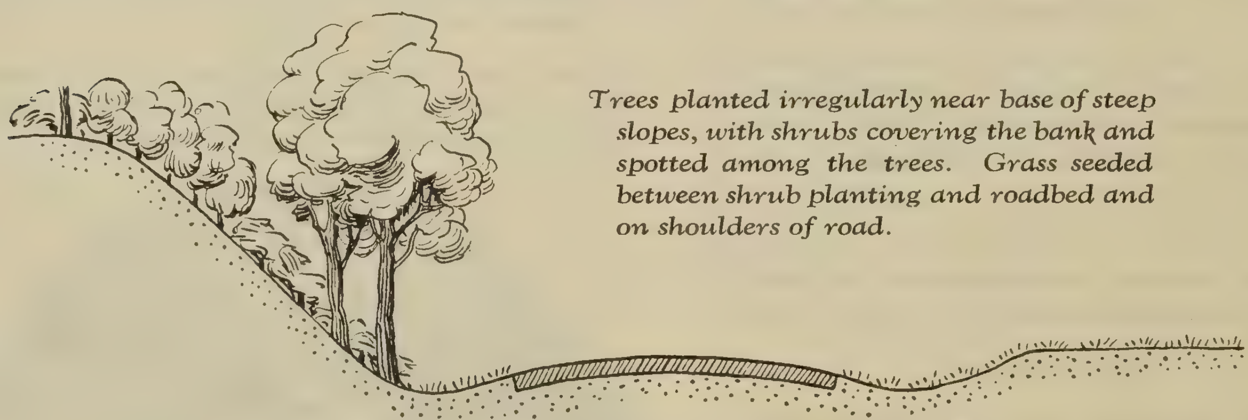
Inlet culverts should be at least as high as the adjoining land, to prevent side gullying along the road and cutting back into adjoining fields. Drop inlets are often essential, if conditions necessary for the establishment of vegetation are to be provided. Neither grass nor woody vegetation can be established or maintained when there is washing or cutting of the soil.

The type of woody vegetation selected should conform closely to the natural growth in that particular locality. Many cultivated trees and shrubs are adaptable for such planting, but their selection should be carefully made.

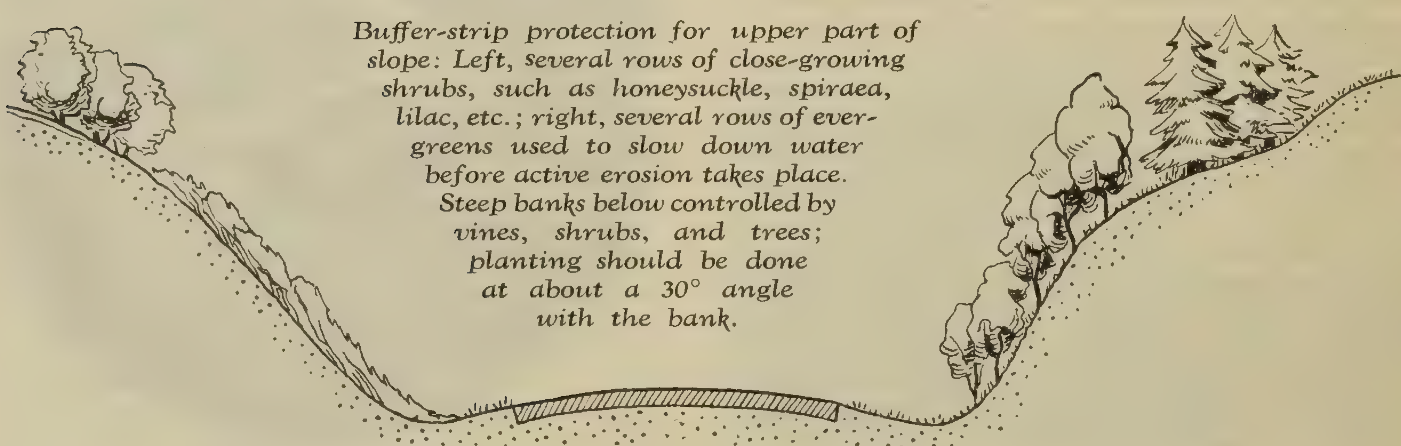
[1] Regional forester, Soil Conservation Service, Salina, Kansas.



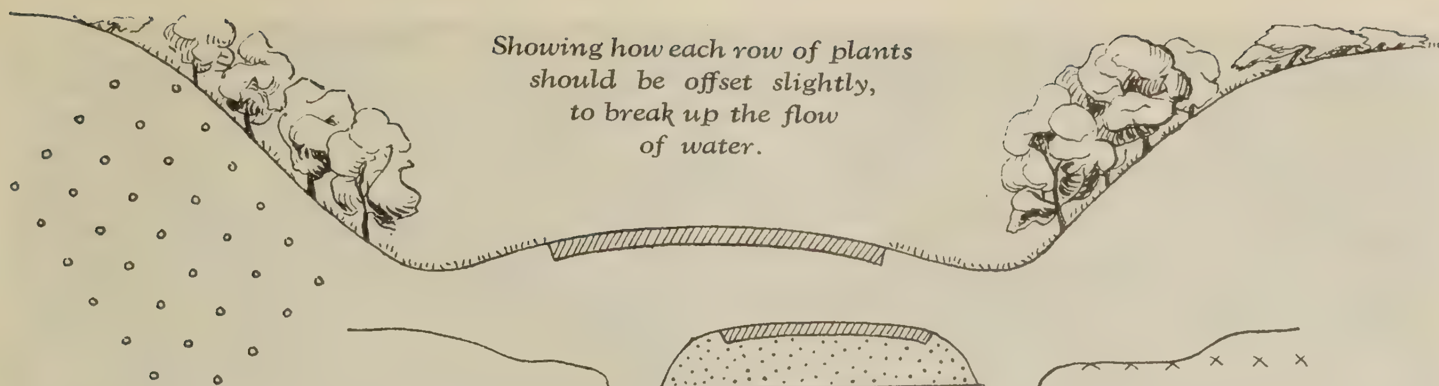
Left, proper roadside grade, permitting establishment of grass mat. Right, improper grade whereon it is impossible to develop a grass covering.



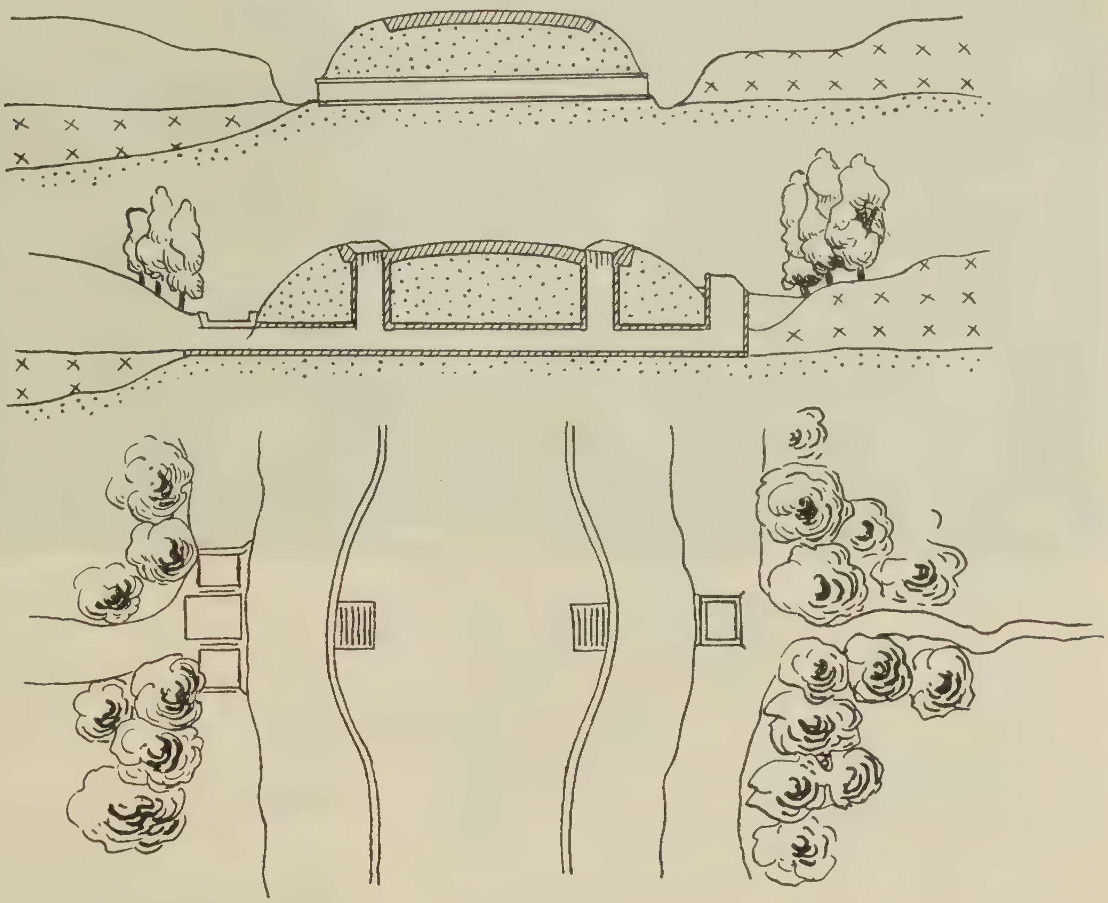
Trees planted irregularly near base of steep slopes, with shrubs covering the bank and spotted among the trees. Grass seeded between shrub planting and roadbed and on shoulders of road.



Buffer-strip protection for upper part of slope: Left, several rows of close-growing shrubs, such as honeysuckle, spiraea, lilac, etc.; right, several rows of evergreens used to slow down water before active erosion takes place. Steep banks below controlled by vines, shrubs, and trees; planting should be done at about a 30° angle with the bank.



Showing how each row of plants should be offset slightly, to break up the flow of water.



Above—The usual type of pipe permitting loss of soil, as indicated by "x."

Below—The drop-inlet type, which saves soil, as indicated by "x," together with widening of roadway over culvert and grating to carry water from road into outlet. Ditch checkers are used on the lower side, and buffer strips stabilize soil deposit.

Heavy Seeding

In planting either grass or shrubs, the seeding should be heavy and the planting close, so that quick coverage will develop. Grass seeding should be heavier than normally used for general field plantings, depending, of course, upon the varying local conditions. Ground-cover shrubs should be set 2 or 3 feet apart, depending upon the steepness of the slope, the fertility of the land, the care they are to receive, and the ease with which they can be established. On steep banks rows of shrubs should be planted at right angles to the flow of the water, and each row offset several inches from the adjacent row, so that, when completed, the water can find no direct passage to the bottom.

An Eye for Beauty

Care should be used in plantings. A combination of shrubs or woody plants should be made with an eye to beautifying the highways as well as stabilizing them. Mass plantings of a single suitable species will sometimes be satisfactory and in keeping with the general surroundings; in other places mixed plantings of two or three species are to be favored. Vines, such as ampelopsis, Japan honeysuckle, or matrimony-vine, often make the best and most appropriate ground cover, and blend with the surrounding vegetation. Other sites lend themselves well to a mass planting of low, compact shrub growth, such as develops from dwarf sumac, Indian currant, or native snowberry.

Triangular areas at the junction of two roads may be made attractive at the same time that erosion is checked. Properly graded and planted, such areas will serve as recreation spots. They should be grassed and planted to trees. If the size of the areas warrant, shrubs may be introduced—low-growing species which will not obstruct the view.

The principal bulwark of woodland against erosion by water. This sievelike organic blanket takes the surface run out of water and causes the water to percolate slowly into the soil.

FARM WOODLAND: CONSERVER OF SOIL AND MOISTURE[1]

By A. E. Fivaz [2]

Early settlers commented excitedly on the dense forests in the humid regions, on the high fertility of the soil, and on the abundance of fresh-water springs and the clearness of the streams in this wooded wilderness. They saw little or no accelerated erosion. Rains fell and snows melted, there was high water but floods attaining the intensity and frequency of those of today were unknown. In times of drought, springs and streams continued to flow from the great soil reservoirs beneath the trees. The abundant ground water and the rich soil provide for a lush growth of vegetation and, in turn, the trees, shrubs, and other woodland plants covered and held the soil against erosion, fostered the storage of water, and constantly contributed to the enrichment of soil. This nearly perfect balance, unfortunately, now has been disrupted over most of the original forest area.

[1] This is the second article in a series which opened in the July number with The Place of the Forester in Soil Conservation, by John F. Preston.

[2] Forester, Woodland Section, Soil Conservation Service.

Above us and all around us in the virgin woods are leaves, twigs, branches, and stems, which expose innumerable little surfaces aggregating an area several times greater than that of the ground beneath. This loosely thatched roof, often a hundred feet or more in thickness, is the first line of protection against surficial run-off and the soil erosion it causes. Driving rains beat upon it but below it the falling water slides meekly down the stems or drips weakly to the ground. As much as half an inch of rainfall may be completely intercepted by this thatch.

Dr. Hans Burger, a pioneer in the study of the partnership of wood and water in Switzerland, states, "After many examinations it is found that the trees of a forest, according to the species of tree and the density of the forest, will hold back 20 to 40 percent of the rainfall, so that it never reaches the ground but evaporates and increases the humidity of the air."

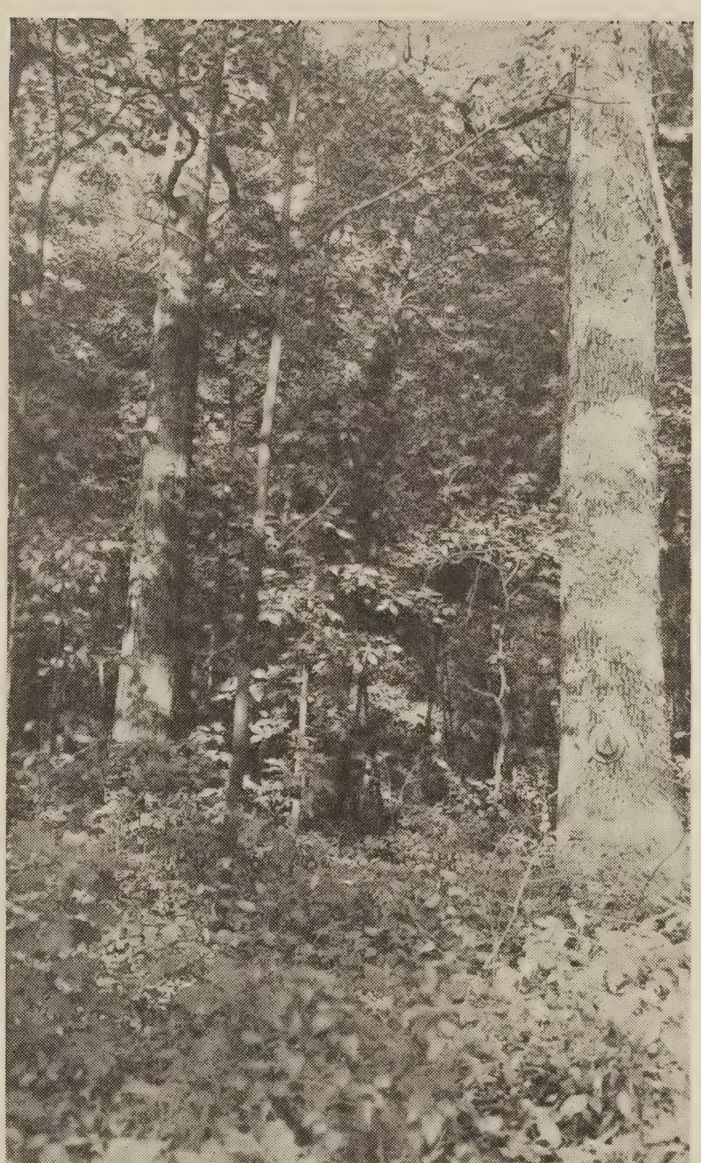
The main bulwarks of woodland against erosion, however, are just beneath our feet. At the surface is the litter and humus, a complete blanket of organic

material such as leaves and twigs in various stages of disintegration. It is not a very smooth blanket but rather an endless series of little depressions. These catch the water that penetrates the thatched roof overhead and restrain it from running away on the surface. The blanket is like a sieve, and the water filters downward through it to the soil beneath. This all-important organic mantle influences the soil in several ways, making it more permeable to the waters that filter through the blanket. The surface of the soil is kept moist and absorbent even in winter when exposed soil is deeply frozen. Organic acids in the humus react to make the soil more porous, giving it what is known as tilth. Furthermore the litter and humus form the principal habitat for a vast population of organisms important to soil building, soil holding, and water storing.

We recognize the forest carpet and the soil that blends into it as the home of rodents, earthworms, ants, larvae of locusts, and other insects, all of which aid in water movement and storage. But, as Dr. Arthur Paul Jacot, of the Appalachian Forest Experiment Station, has stated, "this assortment of odds and ends of the animal kingdom are local in their effects as compared to that of the minute segmented animals (arthropods) so numerous and generally distributed in organic soils as to be of outstanding importance in making and keeping the soil full of minute channels which make it possible for rain water to enter it instead of running off the surface. The intricate, ramifying patterns which these microarthropods establish are of far greater importance in water percolation than mechanical soil porosity—as evidenced in soil which has been so eroded as to have lost this animate layer." Through the agency of these innumerable microanimals, roots and rootlets that have completed their periods of living service and have been softened by fungi are hollowed out to the more resistant bark and became water pipes, rapidly and safely conveying huge quantities of water to the deeper reaches of the soil.

A Subcarpet

Woodland cover has still another line of defense against soil erosion. The intricately woven mass of living roots forms a subcarpet beneath the forest litter with extensions deep into the mineral soil, binding the humus and soil into a mat or a ball that resists erosion. While this line of defense is important only on the steeper slopes in a virgin woodland, it is elsewhere of primary importance when the erosion control efficiency of the forest floor has been seriously reduced by man.



The aerial portion of the trees and shrubs form a loosely-thatched roof, woodland's first line of defense against soil erosion.

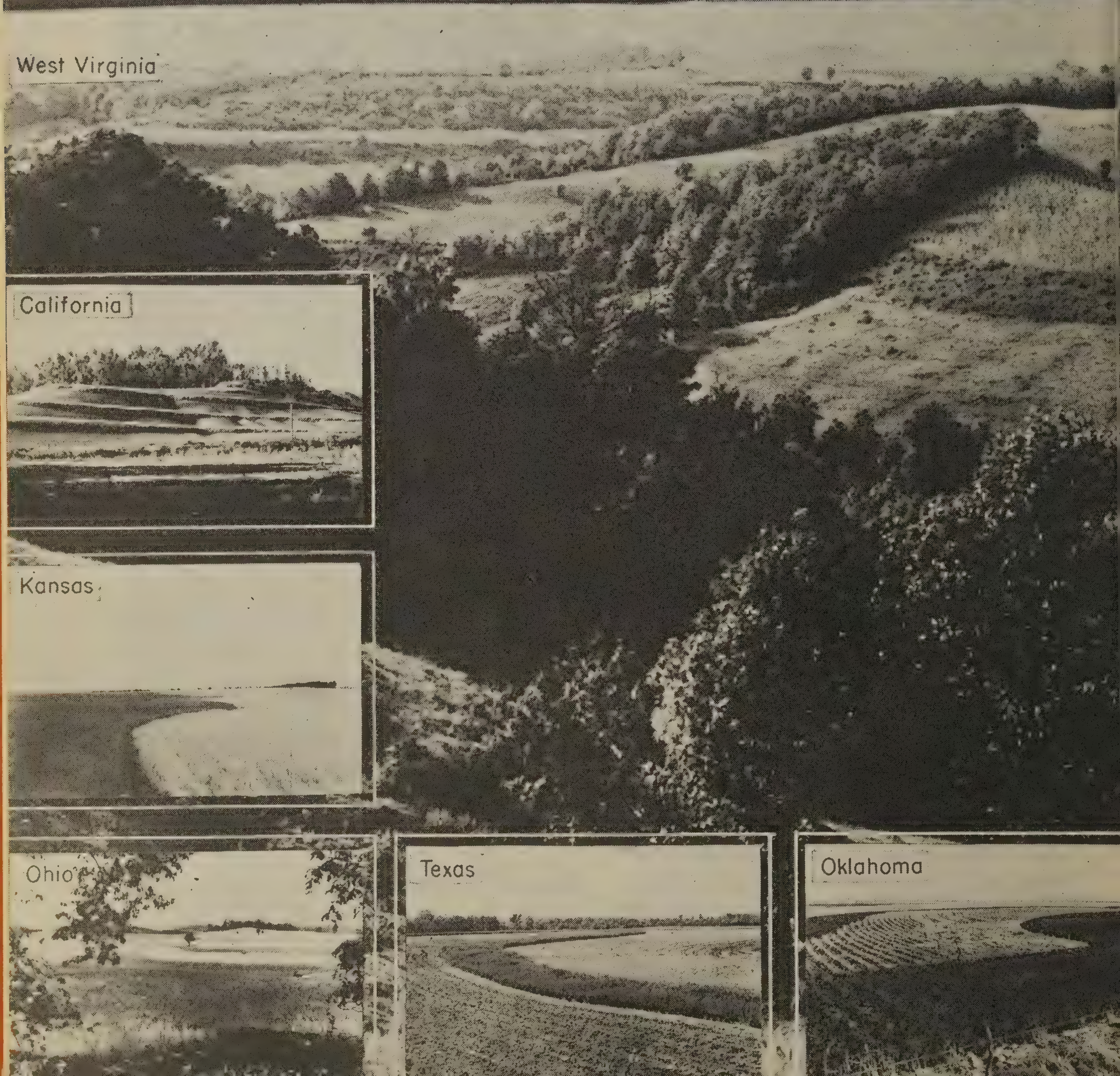
Thus, there is relatively little surficial run-off from a virgin woodland area, and, of course, no soil erosion. Water not evaporated or utilized by the vegetation moves slowly through the soil to feed springs and streams or to replenish deeper stores. With this perfect association of vegetation, soil, and water functioning in the presence of abundant air and sunlight, each associate is preserved and renewed to perpetuity.

Soil Losses Compared

The relative efficiency of woodland cover for soil and moisture conservation as compared with various other uses of moderately sloping land has been demonstrated at several of the erosion-control experimental

(Continued on p. 36)

STRIP CROPPING FR

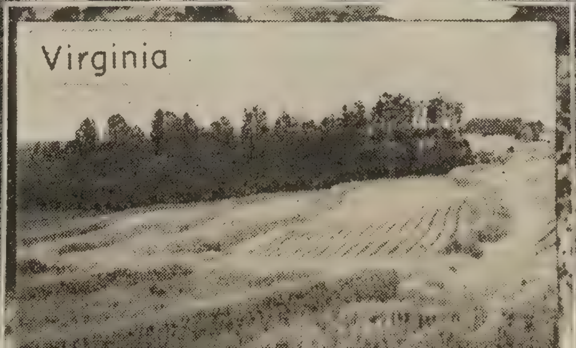


M COAST TO COAST

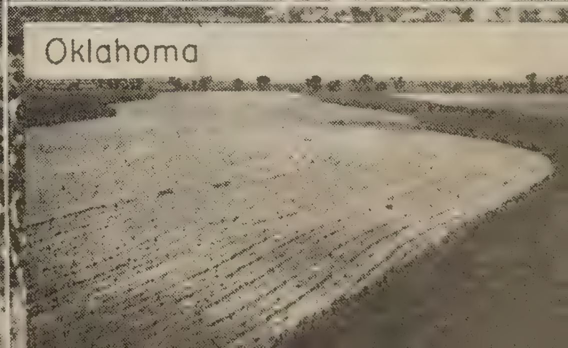
Wisconsin

Ohio

Washington



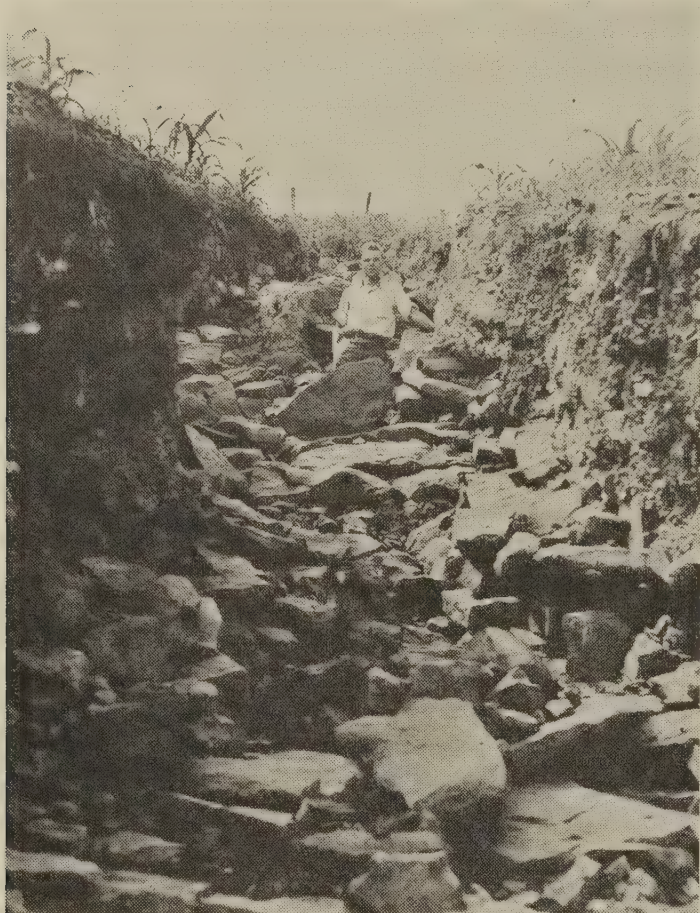
Virginia



Oklahoma

MEASURING THE VENGEANCE OF A SINGLE STORM

By Henry R. Adams [1]



Gullies were cut into bedrock, and large rock slabs were carried onto the fields below.

Highways, railroads, bridges, buildings, and soil within a strip in central and southern New York 20 miles wide and 100 miles long felt the impact of a record-breaking rain on July 7 and 8, 1935.

At Ithaca, close to the center of disturbance, the precipitation amounted to 8.12 inches in 36 hours—5.46 inches in 12 hours. This topped all previous records for intensity.

Transportation was in many places disrupted, 50 lives were lost, and in the wake of the disaster was an enormous erosion damage, with toposil and even growing crops washed from hillsides and with 20-foot gullies drilled over night. Some of these gullies penetrated several feet into the bedrock of shale and sandstone. Sand, gravel, and boulders were strewn over many a formerly productive field to a depth of a foot or more.

The Cohocton River demonstration project lies in the western part of the storm-stricken area. Erosion conditions on more than 30,000 acres there had been studied and mapped previously. After the storm, nine typical farms, comprising an area of 1,560 acres, were remapped by the same men.[2] While it is improbable that this area is representative of the whole storm belt, a comparison of conditions before and after the storm gives considerable information concerning several factors which permit the loss of soil.

The region lies at the northern edge of the Appalachian Plateau and consists of a high, fairly level plain, deeply dissected by steep-walled valleys. The distribution of slopes of different gradients is shown herewith.

Distribution of slopes over 1,560 acres

Percent slope:	Percent of area
0–5	16.9
5–15	37.5
15–25	14.9
25–35	15.9
35	14.6

General Farming Prevails

In most of southern New York, dairying is the principal agricultural enterprise, but here general farming is the usual thing, with potatoes as the chief cash crop. A 4-year rotation of potatoes, oats, and 2 years of hay is commonly followed. The acreage of clean-cultivated crops is higher than in most of southern New York. The approximate distribution of crops over the 1,560 acres studied is shown as follows:

Distribution of crops over 1,560 acres

Crop:	Percent o area
Meadow	28.5
Pasture	24.1
Small grain	16.7
Buckwheat	1.5
Row crops	15.0
Forest	8.0
Idle	5.0
Farmstead and orchard	1.1

This indicates that 33.2 percent of the land was plowed only a few weeks or a few months before the storm, and that 15 percent was planted to clean cultivated crops. More than three-quarters of the crop land, including meadows, was on slopes of less than 25 percent gradient, while nearly one-half of the pasture and about two-thirds of the idle and forest

[1] The author is soil scientist, Soil Conservation Service, Norwich, N. Y.

[2] The mapping in this study was done by W. W. Reitz and H. C. Knoblauch.

land were on slopes steeper than 25 percent. Much of the pasture and idle land is on fields which were under cultivation at one time, but as the fertility decreased, due to erosion and other causes, they were dropped from cultivation. As a result of this unproductive condition, the vegetative cover over much of this land is poor, thin, and weedy.

Gullying the Index

In comparing erosion conditions before and after the storm, gullying was taken as the basis, since it is difficult to evaluate a change in sheet-erosion conditions. It is safe to assume, however, that increased sheet erosion accompanied the gullying and was spread over a comparably large area. The term "gully" in this mapping was applied only to channels which were too deep to be erased by ordinary tillage operations. Rills a few inches deep were classified with sheet erosion.

Of the 1,560 acres studied, 252, or 16 percent, contained new gullies, and on 100 of these (6.4 percent of the total area) these gullies were less than 100 feet apart, or at the rate of more than three to the acre. The storm had deepened old gullies or had cut new gullies deep enough to prevent crossing with ordinary farm implements on 98 acres. Twenty-nine acres were covered with a deposition of rock and gravel, and on 15 acres this deposition was over 9 inches deep.

Gullies up to 20 feet in depth developed overnight.

Twelve acres were covered with silt deposits, which on 2 acres were more than 2 feet deep.

Buckwheat provided little protection to the soil when flanked on the up-side by cultivated crops. This is shown conclusively in this view of a slope strip cropped in oats, corn, mixed meadow, potatoes, buckwheat, and grassy meadow.

Pastures suffered severely during the storm.

It has been generally recognized that a dense cover of close-growing vegetation is an effective natural protection against erosion, and this is borne out by these observations. Forest cover permitted the least erosion and meadow was next. Only 3.9 percent of the meadowland showed the presence of new gullies, while over 15 times that much land in row crops was affected. The acreage of buckwheat was too small to give conclusive evidence, but the results verify other observations that this crop offers little resistance to erosion.

The fact that small grains, seeded only a few months before the storm provided more protection to the land than was given by pasture with a permanent sod cover can be explained by the poor, thin cover of many of the unimproved pastures. Even if the small-grain crops were not fertilized, they were usually following a crop to which a fair amount of fertilizer had been applied. In preventing the formation of frequent gullies, the pasture sod was more effective than the small grains, and the difference was not great in the development of deep gullies.

Much of both pasture and idle land is on run-down, uncared for fields, and about 25 percent of each was gullied before the storm. Nearly three-quarters of the idle land is on slopes steeper than 25 percent, while only about one-half of the pasture is on such slopes. But for some reason, possibly the effect of grazing, the water running over the pastures cut a large percent of the land with new gullies, while on the idle land the water apparently concentrated in the old gullies and cut them deeper, with little damage to the land between them.

In this instance steepness does not appear to have been a dominant factor in erosion on pastures, since over three-quarters of the gullying occurred on that half of the pastures occupying slopes of less than 25 percent. The reason evidently was due to the poor cover which had developed on a few fields of 20 acres or more, largely on slopes of less than 15 percent.

It was noted that gullying occurred in a smaller percent of the pasture fields than anywhere else except meadow, but that the average area affected when a field did gully was much greater in pastures than elsewhere.

Although steepness of slope apparently was of minor importance in pastures, it was a factor of great importance in erosion as a whole. Eighty-two and a half per-

cent of the deep gullying occurred on slopes steeper than 25 percent. A comparison of gullying by slopes on meadows and clean-cultivated fields offers a sharp contrast in erosion over a wide range of slopes.

Gully erosion by slopes on meadow and clean-cultivated fields

Slope	Meadow	Row crops
Percent	*Percent*	*Percent*
0– 5	0	23.6
5–15	4.5	60.1
15–25	6.1	75.9
25–35	11.5	66.9
35	13.3	92.8

The rapid increase in the amount of erosion as the slope increases is readily seen. It can also be seen that adequate protection must be given to land growing clean-cultivated crops even on the gentler slopes.

Strip Cropping

Other observations following the storm showed that good protection was given by an arrangement of fields so that the clean-cultivated crops were in strips extending across the slope between fields of close-growing crops. This practice, which is commonly known as "strip cropping", was effective on slopes up to 25 percent or more. However, it is obvious that greater protection is necessary as the steepness of slope increases and that there is a slope limit, depending on soil, climate, and other conditions, above which it is not economical or practical to attempt to grow clean-cultivated crops and still provide adequate protection.

Over 90 percent of the deposition of sand, gravel, or silt occurred on meadows, pastures, and idle land—fields which were protected by a sod cover. Numerous observations immediately after the storm showed that the grass cover was laid flat by the rushing water and formed a carpet which not only slowed up the water so that it dropped its load, but which also protected the soil beneath from any erosion.

Conclusions

Studies of erosion caused by one severe storm show clearly that erosion is governed by type of soil, vegetative cover, and steepness of slope.

Although this storm was of abnormal severity, the region is subject to torrential summer rains, and its lessons are applicable to farming elsewhere.

The studies indicate that the best natural agent for protecting the soil from erosion is a dense cover of vegetation.

Maintenance of fertility on crop land and improvement of meadows and pastures are necessary to the production of adequate cover, which is of such great importance in an erosion-control program.

Strip cropping gives good protection when row crops must be grown.

Erosion increases rapidly as the steepness of slope increases, and it is much more difficult to prevent it on the steeper slopes.

It is possible to establish a slope limit, depending on soil, climate, and other conditions, above which it is neither economical nor practicable to attempt to grow clean-cultivated crops and still provide sufficient protection to the land.

Meadows and other close-growing crops not only prevent erosion on the land where grown, but they also catch and hold soil material which is being washed down from the land above.

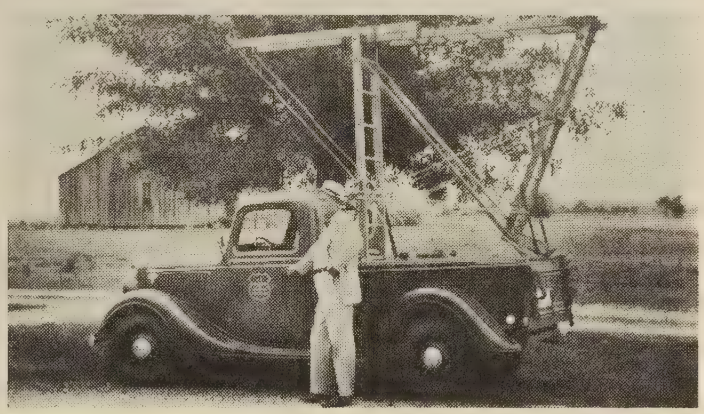


Figure 6.—Ready to go.

MAKING CAMERA EFFECTIVE

(*Continued from p. 24*)

Select the main point of interest to be photographed in the panorama then make as few exposures as necessary to record the scene. If two or three positions cover the subject there is no need for four or five The limit should be five. Views of two or three exposures are useful for certain types of publication; however, longer panoramas cannot be reproduced conveniently.

Five scenes covered by an 8½-inch lens embrace a greater area than when a longer focal lens is used. However, with the longer focal length lens more depth may be secured.

Prints may be made from the negatives in the ordinary way. Be sure to make the prints uniform, of the same shade and density to insure perfect matching. A practical method is to match the negatives in a printing frame first, and print as one print from paper cut to proper length. Thus, more even matching is assured and the laps and spliced joints avoided.

FARM WOODLAND : CONSERVER

(Continued from p. 29)

stations of the Soil Conservation Service. As against negligible run-off and soil loss amounts for woodlands and slightly greater but still negligible corresponding figures for grasslands, the annual run-off records range from 14 percent for good crop rotations to 30 or 35 percent for continuous row crops, and as much as 44 percent for fallow land. Soil losses range from 3 to 65 tons per acre per year for these land uses. It is indeed fortunate that there remain in our agricultural regions over 185,000,000 acres of farm woodlands.

These woodlands are a far cry, for the most part, from the virgin forests that once occupied their sites. Many acres of these woods are struggling on areas but recently abandoned and removed from cultivation as a result of erosion or soil depletion. The few years of tillage have destroyed the favorable soil structure that nature painstakingly built up over centuries, and dissipated the organic content of the soil so important to its moisture-retaining, erosion-resisting, and growth-favoring capacities.

The influences of tillage are well illustrated by the experience of Dr. C. A. Schenck, an internationally recognized forester, on an estate in North Carolina. Given the task of reforesting the many farm fields that made up the tract, Dr. Schenck observed the fine form and growth of important "climax" hardwoods in adjoining sites of the same soil type which had never been deforested, and he tried to reforest the fields with hardwoods. Many of the trees died and those that survived made so little growth that they could hardly compete with the weeds and grasses. The tilled soil, which but a few years before had had the structure and composition of that in the woods at the edge of the field, would no longer support the climax forest vegetation represented by the woods. Dr. Schenck turned to pines and spruces, more primitive species in nature's succession, and these have been successfully established. If these areas are undisturbed over the course of several rotations, the soil conditions essential to the climax hardwoods will be restored and the site will again be occupied by them. It is obviously better woodland economics to dedicate sites permanently to woodland use rather than to rotate woodland and tillage as we have usually done in the past.

Grazing of woodland areas may destroy the woodland cover, and on slopes such as this leads to the destruction of the soil.

The Evil of Burning

Our farm woodlands are frequently burned, either accidentally or intentionally under various barbaric theories arising from our forefathers' struggle to establish tillage in a wilderness. Fire works in several ways to reduce the effectiveness of woodland in conserving soil and moisture. The so-called "harmless" ground fires, intended to "clean up the woods," to "kill boll weevils", or to accomplish other legendary objectives, are especially damaging to the essential mantle of litter and humus. A single severe fire or repeated light burnings consume this organic material, decimate beneficial soil fauna, and materially increase run-off and erosion. Soil-erosion experiment station results indicate that annual burning of woodland increases run-off from 10 to 30 times and soil loss from 12 to 300 times.

Unwise use, exemplified here by cutting without provision for natural regeneration of the woodland cover, creates serious erosion hazards not only to the woodland site itself but also to good agricultural lands and watercourses below.

Fire destroys the seed and seedlings on which woodland renewal depends. When severe, it destroys mature trees, but in farm woodlands this is usually less of a factor than its unholy alliance with fungi. Rot-causing organisms enter the trees through basal fire scars and reduce or destroy the crop value of the affected trees.

Overgrazing Versus Profitable Grazing

In still another way are natural conditions in farm woodlands materially changed through unwise acts of man. Nearly three-fifths of these 185,000,000 acres are grazed by domestic animals. Except in certain limited areas of open woodland where grasses and trees form a congenial association, grazing is a double-barreled uneconomic practice. On the one hand, woodland pastures provide little more than bare subsistence grazing as contrasted to profitable grazing. The grass is sparse, scattered, and unpalatable, and actual measurement of changes in weight of stock forced to graze in woodlands indicate that the practice is economically unsound purely from the livestock standpoint. On the other hand, grazing causes cumulative damage to the woodland cover, ultimately resulting in its destruction. Increased run-off and erosion accompanies this damage.

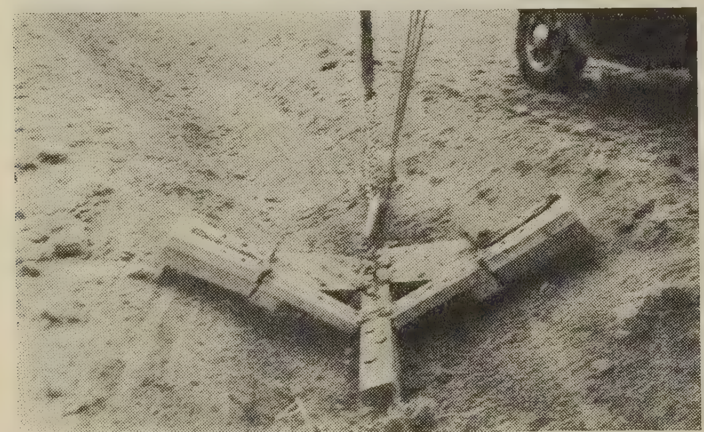
The browsing of foliage and "riding down" of saplings, especially hardwoods, soon eliminates the younger-age classes. By preventing natural reproduction in these types, grazing changes the lease of woodland on the site from a normally permanent one to a term lease, terminable at the maturity of the youngest tree—a maturity which is further hastened by other grazing influences adverse to tree growth. In practically all woodland types grazing animals cause openings in the protective forest canopy, which steadily increase in size. As a greater proportion of light reaches the forest floor, the organic mantle breaks down and inferior grasses and weeds increase. The soil is compacted by trampling, its structure is changed and it becomes much less permeable.

(Continued on p. 40)

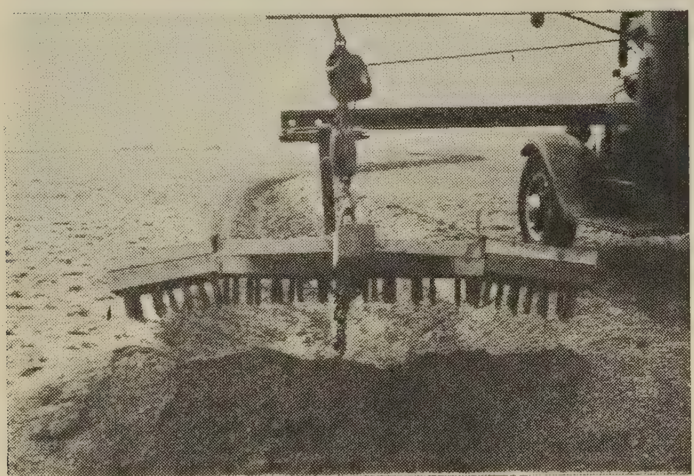
A DEVICE THAT FACILITATES SEEDING OF PASTURE TERRACES AND CONTOUR FURROWS

By Wayne Austin [1]

Pasture terraces and many of the larger contour furrows in Colorado are made with either a road grader or a disk plow. These implements leave the sides of the terraces below the ground level very smooth and hard. It is useless to broadcast seed in this type of furrow until some sort of seedbed can be prepared.



Ready to begin work.



Up and over a cross dam.

Reharrowing a pasture terrace after it has been seeded.

A brush drag first was tried but without success. The sides of the furrows were so hard and smooth that the seed was brushed to the bottom of the ditch, where it was left without any covering. When the wind blew, most of the seed was scooped out of the furrow, scattered over the prairie and lost, or was pocketed in protected places.

A flexible-winged, V-type harrow was built for use in these furrows. The next problem was how to pull it and how to get it over the cross dams that are built in the terraces every 80 to 100 feet. This was accomplished by tying two 15-foot railroad irons across the bed of a truck. The harrow was fastened to the forward iron by means of a log chain. The rear rail was placed directly over the harrow, and a block and tackle was fastened to the center of the harrow. A man riding on the bed of the truck pulls the rope at the proper time, and this lifts the harrow over the cross dams as they are reached. The furrows are first harrowed, seeded with the broadcaster, and then reharrowed.

This type of harrow prepares a very good seed bed and yet does not destroy the structures. The seed is sufficiently covered with soil by reharrowing to protect it from the wind and give it a chance to germinate. One truck and two men can harrow 30 to 40 miles of contour per day with this equipment.

The accompanying photographs show the harrow at work on pasture terraces in the Black Squirrel Creek area.

[1] Assistant agronomist, Soil Conservation Service.

Index Available

An index covering Volume I of Soil Conservation (August 1935 to June 1936, inclusive) is now ready for distribution on a restricted basis.

Crider Honored

F. J. Crider, head of soil conservation nurseries, has been awarded the degree of Doctor of Science by the University of Arizona. This was in recognition of Dr. Crider's leadership in the development of horticultural sciences in the Southwest, his scholarship in plant nutrition, and his contributions as teacher, research worker and regent of the university.

President Roosevelt has appointed H. H. Bennett, Chief of the Service; Morris L. Cooke, Administrator of the Rural Electrification Administration; and F. A. Silcox, Chief of the Forest Service, as a special committee to call a conference of experts from the United States and foreign countries in Washington, September 22 and 23.

The purpose of the conference is to assemble data on "up-stream" engineering in relation to flood control and land conservation.

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

SOUTHERN REGIONS OF THE UNITED STATES. By Howard W. Odum. 1936.

A work such as this, about the South, out of the South, prepared by a man who for many years has labored for the advancement of southern interests, should and will have far-reaching influence not only in the region covered by the volume but in the future of the Nation's readjustments as well. Dr. Odum, of the University of North Carolina, here presents an extraordinarily detailed and realistic picture of the southern United States, formerly designated as the South, now characterized in this work as southern regions, clearly differentiated into the older Southeast and the emerging new Southwest. Although in the indexes is to be found vast comparative data involving other regions and the United States as a whole, the book is, essentially, a book of the Southeast.

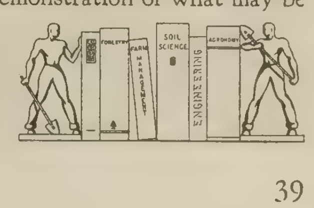
Can the southern regions, set in the midst of a superabundance of nature's wealth, abounding in multiple resources of geographic variety, of human stock, and of cultural tradition, occupying strategic positions within the Nation and in relation to the nations of the world, continue to feature deficiency, marginality and immaturity, framed in isolated sections separate from the Nation, except as a peculiar phenomenon of cultural pathology? With a wealth of inventory of fact and actualities, with data on industry and agrarian resources, technology, deficiency, and waste, human culture and institutions, the author answers these queries, working toward and including a study on regional planning for southern United States. It might seem to the casual reader that Dr. Odum had written an unsympathetic book; on the contrary it has the tone of urgency—it shows us the southern regions as they are, almost, it might be said, to the last gully, so that out of this period of reconstruction there may come something, at least of permanent value to the South and to the Nation.

Naturally, the disturbing story of the South's eroded soils, misuse and abuse of rainfall, rivers, and streams, occupies an important place in the sections of the book which treat of deficiency and waste. With the authority of the man who knows his regions and need not theorize, Dr. Odum states baldly that soil waste in southern regions "is measured in terms of more than half of all the Nation's erosion toll." Using the estimates of the Chief of the Soil Conservation Service, H. H. Bennett, who for many years has surveyed, sampled, and studied the soils of the Southern States, Dr. Odum presents the tragic picture of topsoil depletion in the Carolinas, Georgia, Alabama, Louisiana, Arkansas, Tennessee, and Virginia. That there should be a single county in the South Carolina piedmont where 277,000 acres of land have been seriously affected by erosion, is in the fact itself an urgent plea to right-about and face the issue of the South's urgent need for planned conservation and reconstruction.

Another factor which has caused large waste of arable land in southern regions—deposition of erosional debris over alluvial bottoms—receives treatment. An immense aggregate area of formerly rich bottom land has been affected by frequent overflows from streams with choked channels, and by deposition of sand and gravel and other material washed down from the hillsides, covering the soil and rendering cultivation precarious, if not impossible. As to the single-crop system of the South, followed persistantly throughout the generations, Dr. Odum points to cold figures representing annual purchase by the Southeast of 5½ million tons of commercial fertilizer as compared with all the rest of the Nation's 2½ million tons. He tells of "vast gullies and gulches, wagon-wide and tree-deep, spotty hillsides, and great stretches of fields marred like some battlefield" and a stupendous drain on soil elements essential to plant growth by deficiency of agricultural methods, which if continued would make the region impotent for agrarian culture or to supply wealth of any kind adequate to support industry and mercantile interests.

In a masterful discussion of the South as an agrarian country special consideration is given the possibilities of subregional classifications in the light of present-day problems. A vast amount of information and data is given in text and indices to show the complex picture in its manifold detail. Herein the reader-student is brought face to face with the figures which depict the exigencies of farm life on millions of small and poorly equipped farms; with the hazards of financing, high interest and poor credit; with soil erosion and depleted natural resources; with the picture of a million prospective squatters and migrants; with lowered standards of living and social deficiency. Within this specialized examination of the subregions the subject of farm areas is considered in the light of regional variations of basic factors—geography, soil, climate, topography, general cultural and folk-institutional ways, labor and supply, agricultural mechanization, markets and transportation, cooperative agencies. And herein is included a study of the 1,100,000 "cotton" farms of the Southeast, backed by fact and figure, to the effect that at the present rate of soil depletion the Southeast cannot continue to produce the present maximum of this crop without further and inevitable destruction of resources.

As this study of the cotton outlook reveals the urgency for a substitute economy which will effectively merge economic and social diversity with cotton economy, Dr. Odum passes swiftly and expediently to an exploratory survey of the southern uplands as regions suitable for an expansive dairying industry. Here the author finds hope for the Southeast, saying: "These studies of new prospects for dairying are fundamental to the whole question of agricultural reconstruction and agrarian life in the South. It is, indeed, through the very realistic, practical, subregion by subregion approach that the picture must be painted or success attained rather than through the ideological motivation for an abstract agrarian culture. To use Mississippi as an example, at least half the people now live on tenant farms. Those counties having the largest ratios of tenancy also show the largest ratios of illiteracy and other measured deficiencies, yet show the smallest sized value of all farm products sold. This does not mean the highest ratio of vegetables raised in farm gardens, or of checkens and eggs produced, or dairy cows on farms; but crops sold for cash, where in this case the cash does not go to the farm tenant. In the statistics for these four aspects of farm life—dairying, dairy cows on farms, farm vegetables grown in farm gardens, poultry produced and used at home—may be found experimental demonstration of what may be accomplished through the reconstruction of farm life. Of special importance is the new program of County-State-Federal cooperation in soil



erosion and conservation of land." Further, Dr. Odum writes: "Nevertheless, the dream of a revitalized agrarian culture in the Southeast must be given the fullest possible consideration, both because of inherent possibilities and because of the case which is being made for it on many sides."

The first general conclusion drawn from this extensive volume is that the task of planning the safe and sure future for the Southeast is an extraordinarily difficult one, but that all the elements for success are present provided they can be focused in the right ways and combinations. On the other hand, it is evident that the writer visions from the wealth of evidence set forth that unless there is a definite change in regional economy there will be retrogression in agriculture, in industry, and in general culture and institutions. It is to be hoped that, when the year of midcentury rolls round, those who labor and hope and plan for the South may turn for comparison, and with pride of achievement, to this vivid and detailed southern picture of the year 1936.

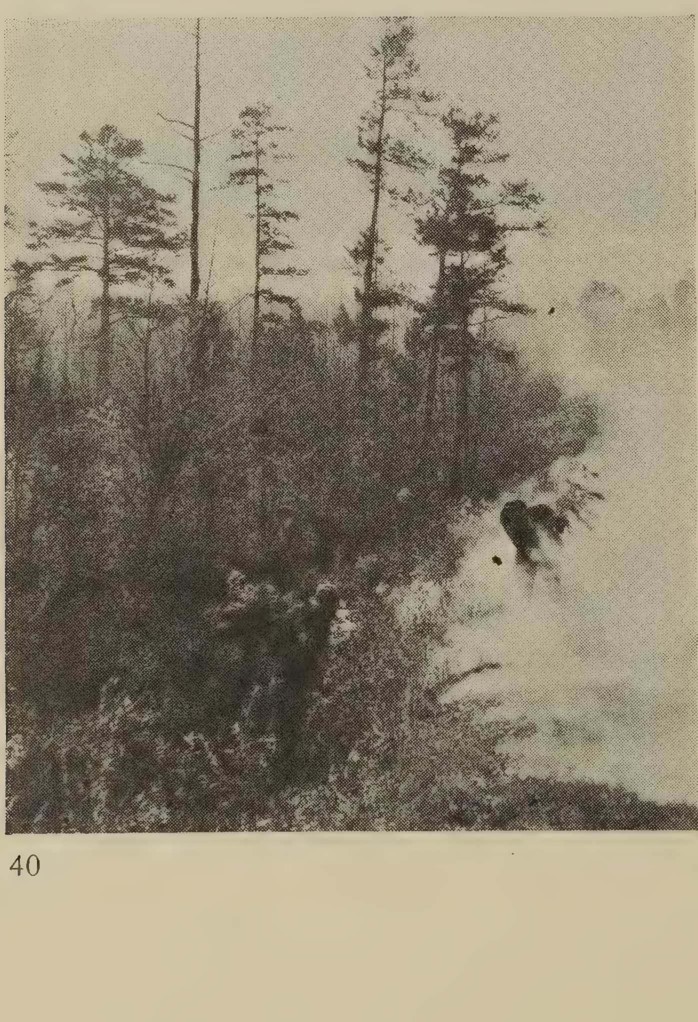
FARM WOODLAND: CONSERVER

(*Continued from p. 37*)

Dr. Burger states, "Many hundreds of experiments, carried out all over Switzerland, show that pasture lands are almost nonporous. Three to five times better is the permeable earth of the hayfield and ten to thirty times better that of good, uncultivated forest floors."

The roots of neighboring trees, no longer adequately protected by litter and humus, and influenced by the soil changes, exposure, and direct trampling, are more readily susceptible to damage by drought. Cooperative studies by the Purdue University Agricultural Experiment Station and the Central States Forest Experiment Station show that, as a result of grazing, the growth and vitality of large trees are affected. Soon they become stag-headed, the openings in the canopy get larger, and eventually the woodland is no more.

Ground fires destroy the organic blanket laid down by woodland cover and materially reduce protection against excessive run-off and soil erosion.



Finally, the sound natural conditions of our farm woodlands have been materially altered by unwise, unthoughtful, or greedy cutting. Nature does not deny man the use of trees, since trees have a relatively definite natural span of life and can reproduce their kind. It is only when man cuts in ignorance or disregard of natural processes that Nature fails to reproduce woodland as good if not better than that removed. Cutting without benefit of silviculture has denuded some sites and has so altered the composition of woodlands on others, as to create problems almost impossible of early economic solution and generally has lowered the productive capacity of farm woodlands. All of these conditions have a direct bearing on soil and moisture conservation. The permanency of woodland cover, so important to soil and moisture conservation, is primarily dependent on its economic value as a producer of fuel and lumber. When opportunity for income diminishes or disappears, woodland cover soon gives way to uses which are more immediately profitable but hasten the process of erosion.

Farm woodlands, even in their present deplorable condition, are important bulwarks of soil and moisture conservation, and their perpetuation and more effective functioning are much to be desired. This can be brought about only by a complete overhauling of practices with respect to their management, protection, and use.

Under agreements between farmers and the Soil Conservation Service, there are scheduled for construction during the next 3 years more than 36,000 miles of farm terracing, or enough to make 14 terraces from New York City to Los Angeles.

Especially on moderate slopes of deep, porous soil are terraces valuable, but they are only one part of erosion control, and must be supplemented by ample vegetation, proper cropping and tillage practices, and increased planting of soil-binding crops.

U. S. GOVERNMENT PRINTING OFFICE: 1936

SOME RECENT PUBLICATIONS ON CONSERVATION AND RELATED SUBJECTS

Compiled by Mrs. Etta G. Rogers

Field offices of the Service should follow the procedure outlined in Field Memorandum No. SCS-218 for ordering publications. Others should address the office of issue

Office of Information, United States Department of Agriculture

Genera of Grasses of the United States. Bulletin 772. Issued March 1920, revised May 1936.

Growth and Survival of Deciduous Trees in Shelter-Belt Experiments at Mandan, N. Dak., 1915-34. Technical Bulletin 496. February 1936.

Irrigated Crop Rotations in Western Nebraska, 1912-34. Technical Bulletin 512. May 1936.

Timothy Seed Production. Leaflet 115. February 1936.

Agricultural Experiment Station

Adequacy of the Boron and Manganese Content of Natural Nitrate of Soda to Support Plant Growth in Sand Culture. Bulletin 603. Agricultural Experiment Station, New Brunswick, N. J. 1936.

Agricultural Program for North Carolina. Extension Circular 208. Extension Service, State College of Agriculture, Raleigh, N. C. February 1936.

Alfalfa in Michigan. Circular 154. Agricultural Experiment Station, East Lansing, Mich. 1936.

Better Plowing. Circular 450. Extension Service, College of Agriculture, Urbana, Ill. March 1936.

Changes in the Oxidation-Reduction Equilibrium in Soils as Related to the Physical Properties of the Soil and the Growth of Rice. Bulletin 271. Agricultural Experiment Station, Baton Rouge, La. January 1936.

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Economic Study of Land Utilization in Chemung County, N. Y. Bulletin 640. Agricultural Experiment Station, Ithaca, N. Y. January 1936.

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Effects of Liming on the Liberation of Potassium in Some Iowa Soils. Research Bulletin 197. Agricultural Experiment Station, Ames, Iowa. April 1936.

Evaporation Survey of Ohio. Bulletin 564. Agricultural Experiment Station, Wooster, Ohio. March 1936.

Farm Windbreak. Circular 267. Extension Service, College of Agriculture, Madison, Wis. Issued April 1934, revised February 1936.

Grain Sorghum Production Relative to Planting Date and Row Spacing. Panhandle Bulletin 60. Panhandle Agricultural Experiment Station, Goodwell, Okla. June 1936.

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Influence of Climate, Soil, and Fertilizers Upon Quality of Soft Winter Wheat. Bulletin 563. Agricultural Experiment Station, Wooster, Ohio. March 1936.

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Pasture Investigations.—Eighth Report. Modifying the Seasonal Growth Habits of Grasses. Bulletin 209. Agricultural Experiment Station, Storrs, Conn. March 1936.

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Pertinent Points Concerning Soil and Its Management. Extension Bulletin 218. Extension Service, State College of Washington, Pullman, Wash. April 1936.

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Rating of California Soils. Bulletin 599. Agricultural Experiment Station, Berkeley, Calif. January 1936.

Readjusting Montana's Agriculture.—VI. Montana's Irrigation Resources. Bulletin 315. Agricultural Experiment Station, Bozeman, Mont. March 1936.

Relation of Physical Properties and Chemical Composition of Red Clover Plants to Winterhardiness. Bulletin 391. Agricultural Experiment Station, College Park, Md. 1936.

Report on the Investigation of Phosphorus-Deficient Soils, 1935. Bulletin 316. Agricultural Experiment Station, Bozeman, Mont. March 1936.

Residual Effects of Some Leguminous Crops. Bulletin 645. Agricultural Experiment Station, Ithaca, N. Y. March 1936.

Sand Culture of Seedlings. Bulletin 380. Agricultural Experiment Station, New Haven, Conn. January 1936.

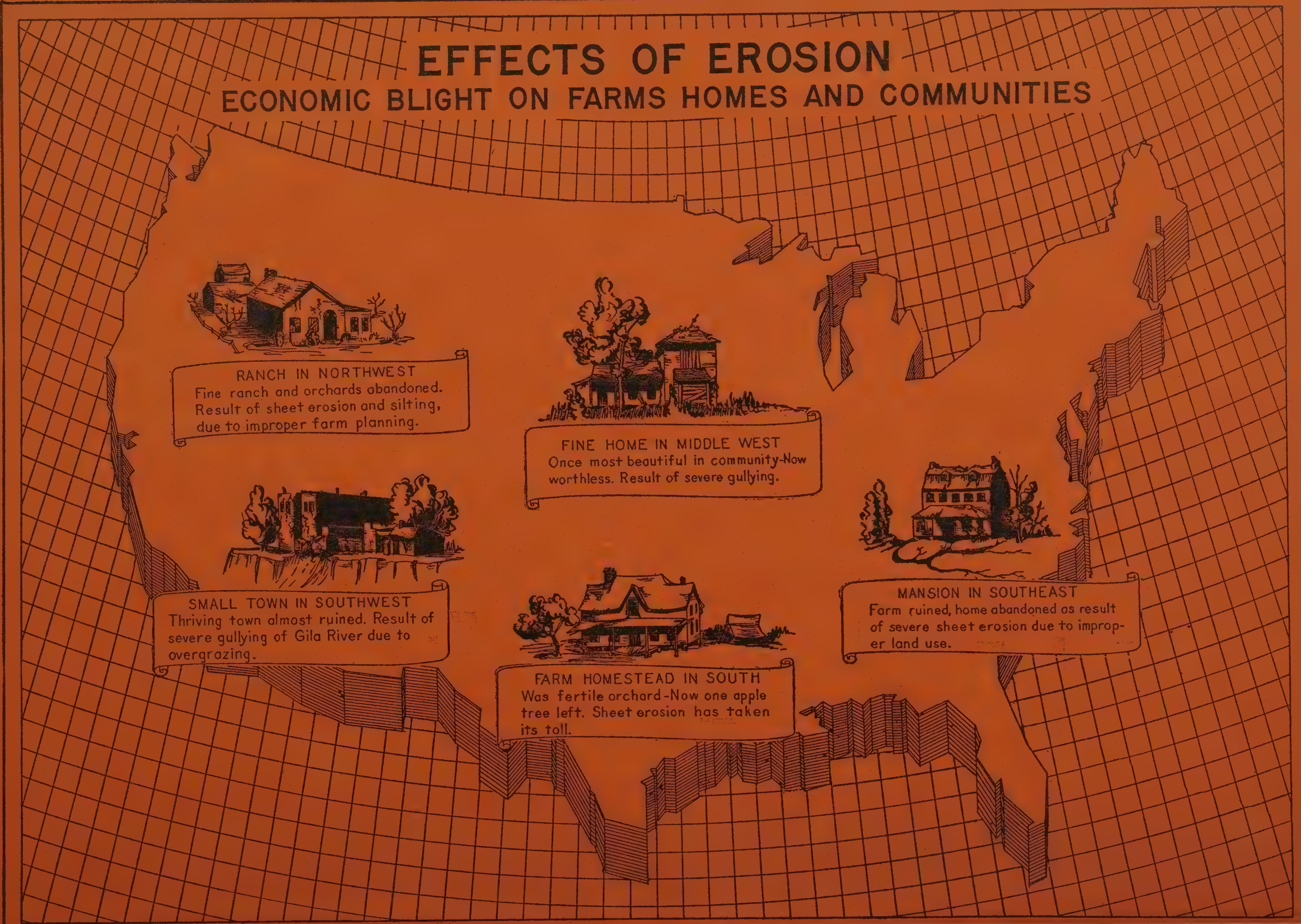
Shriveled Light Weight Wheat, Is it Suitable for Seed? Circular 59. Agricultural Experiment Station, Fargo, N. Dak. February 1936.

A Social and Economic Survey of the Spencer Soil Conservation Area. Bulletin 269. Agricultural Experiment Station, Morgantown, W. Va. 1936.

Soil and Rainfall Conservation in New Mexico. Bulletin 238. Agricultural Experiment Station, State College, N. Mex. April 1936.

Soil Management and Crop Production Studies, Carbon County Area. Bulletin 270. Agricultural Experiment Station, Logan, Utah. February 1936.

Today's Science for Tomorrow's Farming. Bulletin 435. Agricultural Experiment Station, Madison, Wis. March 1936.


EFFECTS OF EROSION
ECONOMIC BLIGHT ON FARMS HOMES AND COMMUNITIES
RANCH IN NORTHWEST
Fine ranch and orchards abandoned. Result of sheet erosion and silting, due to improper farm planning.
FINE HOME IN MIDDLE WEST
Once most beautiful in community-Now worthless. Result of severe gullying.
SMALL TOWN IN SOUTHWEST
Thriving town almost ruined. Result of severe gullying of Gila River due to overgrazing.
FARM HOMESTEAD IN SOUTH
Was fertile orchard-Now one apple tree left. Sheet erosion has taken its toll.
MANSION IN SOUTHEAST
Farm ruined, home abandoned as result of severe sheet erosion due to improper land use.

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

SEPTEMBER 1936

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Cover design suggested by photograph reproduced on page 60

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WELLINGTON BRINK — EDITOR

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

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SEPTEMBER • 1936

ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

EROSION DEFENSES WITHSTAND POUNDING OF RECORD RAINS

By Harold G. Anthony

The manner in which complete coordinated erosion-control measures on land of cooperating farmers with the Soil Conservation Service in the Plum Creek demonstration project withstood torrential rains and flood waters last night was remarkable.

That's the wording of a telegram received on the afternoon of July 7 from W. H. Du Puy, of Lockhart, Tex., project manager of the area comprising Caldwell and Hays Counties.

Let it be said right here that Mr. Du Puy's telegraphic message was an understatement.

I arrived at Lockhart 24 hours after an 8.38-inch rain had fallen in a matter of 6 hours. This was the heaviest downpour since 1902 and through one period of 20 minutes it reached a maximum intensity of 4 inches per hour. Plum Creek went raging out of its banks and 13 lives were claimed by the unleashed waters in and around the villages of Uhland and Kyle, in the heart of the project area. Other rains during the day preceding my arrival brought the total precipitation to well over 9 inches.

Accompanied by other staff members I went for a first-hand look at the erosion-control program under the strain of such a test.

Unrestrained Waters at Work

Now, I want you to come along with me. Get the picture.

We are sitting in our car, 4 or 5 inches of water swirling over the highway, near the little community of Uhland. On our right is a farm totally unprotected from erosion. Nearest us is a large, sloping field planted to cotton and corn. Between every two rows is a stream of muddy water rushing toward the roadside ditch. As we watch, we see the water cutting loose soil, gouging out holes. We see small gullies between the furrows turning into gaping gashes in the cultivated field. We see furrows disappearing, melting into the water. On the lower edge of the field there is a deposition of topsoil, washed from the slope above, gradually growing deeper, spreading out, relentlessly covering growing cotton and building up around stalks of corn. In many instances cotton is being uprooted—dug out by the rapidly flowing water.

What we see here is not only the virtual destruction of a cotton crop. More serious and far-reaching is the fact that here is the wasting away by water erosion of good farm land that will never again—certainly not in several generations—reach its former peak of productivity. The very life of the land, tons and tons of rich topsoil, is being washed away, never to be returned except through the slow processes of nature.

Multiply the scene by a hundred, yes, even a thousand, and you will have some idea of the destruction wrought by a single cloudburst on acre upon acre of unprotected land in the watershed of

Two-foot deposit of soil covers cotton at left. This unprotected field furnishes evidence of tremendous soil movement by water.

Huge silt deposit made by soil swept from unprotected field.

Portion of roadway on Siley Valley highway swept away for distance of 150 feet by flood waters.

A–1 bottom land at Uhland, Tex. Scoured out to hard subsoil, entailing loss of 6 to 8 inches of good topsoil over entire field. Field above protected by vegetation and contour ridges suffered no damage from washing or gullying.

Plum Creek. Add to this, also, the loss of life, the damage to highways and railways, the destruction of homes, and you will readily agree that if the more extensive application of proper erosion-control measures could have prevented even one-tenth of the tragedy, the expense and effort would have been well worth while.

By Way of Contrast

Now let's look at another farm. We are still near Uhland in the Plum Creek demonstration area. The farm we now see is under cooperative agreement and the complete, coordinated erosion-control program has been instituted on each acre.

Stretching out across one of the fields is a well-planned system of sorghum strip crops. Instead of water sweeping tons of topsoil off this field we see each contoured furrow filled with water that is gradually finding its way to a lower level. Water flowing into the strips of sorghum is so slowed down by the fibrous-rooted plants that it actually backs up above the strip. Soil held in suspension is dropped. A close inspection of water coming from the strip nearest the road reveals that it is clear, free of soil. The water runs out from the strip slowly, evenly, and does not cut or wash.

On a field of the farm having a slope of about 4 percent we see in addition to strip crops and contour cultivation a system of wide base Mangum terraces. The terraces, almost filled to the top with water, are unbroken. Excess water is flowing slowly through vegetated outlets into a well-sodded channel that delivers it safely to stream level.

Holding on Hillside

There is a third field with a still steeper slope. This is a new pasture—land too steep for safe cultivation. Grass and contour ridges are doing a perfect job of holding the water on the hillside, thereby cutting the

Two- to three-foot deposit of silt formed by soil swept from unprotected field. Original height of corn about 6 feet.

rate of run-off to a minimum. There is no apparent erosion on this hillside.

What we have seen, of itself, needs little elaboration. It is an actual and enlightening contrast of farm lands unprotected by erosion-control measures with a farm under the erosion-control program of the Soil Conservation Service. The pictures just described could be duplicated in any part of the Plum Creek demonstration area.

Mr. Du Puy pointed out to me that any farmer could apply the same erosion-control measures to his land as are being instituted cooperatively here on more than 10,000 acres in the area. Said he:

This work is as simple as it is effective. Our program of erosion-control measures is built around the use of vegetation and proper cultural practices, with engineering devices used only where they are absolutely necessary. Cover crops, well-planned rotations, and contour cultivation are all integral phases of our program. These cultural practices, with strip crops and terraces where necessary, and the handling of excess run-off water by the use of sodded channels, by meadows strips, or by dumping it onto well-sodded pastures, all work together to cut erosion hazards to a minimum on cultivated areas.

The proper use of each acre of the land is, of course, the foundation of our program. Steep slopes cannot be safely cultivated, so such areas are retired and put into pasture or woodland when that is practicable. Once sod, pasture grasses, or trees become established on steep slopes, there is little danger of erosion. On pasture lands the farmer builds contour ridges which hold the water, furnishing moisture for the grasses, as well as slowing run-off.

From the flood-control angle, erosion-control measures are of great importance, Mr. Du Puy pointed out. Every phase of the coordinated erosion-control program is directed toward holding water on the land so that it will have an opportunity to soak into the ground and so that excess water will run off slowly and without scouring, washing, or undue concentration. Floods are nothing more than the result of a

(Continued on p. 57)

Clear water coming from strip crop. In this 84-acre field are 22 acres of strips, each averaging 20 feet in width. A strip of alfalfa at upper end of field was plowed under before flood, that portion showing erosion afterward.

Terrace holding water. At lower left may be seen water flowing through vegetated outlet into well-sodded channel. No erosion on this field. Terrace to be stripped with peas.

Deposit of silt just above strip crop of redtop sorghum. Strip proved effective in slowing flow of water and causing soil in suspension to be dropped. Note water continuing to flow into strip.

Silt deposit above Hubam strip. This is a 24-acre field with 6 acres in strips. Maximum slope length 700 feet, average degree of slope 2½ percent, average strip width 25 feet. Hubam clover, alfalfa, peas, Sudan, and sorghum are favored for strips.

Sodded outlet channel. It not only carried big flow of water from terraced field but also caught water which flooded over highway. No scouring, cutting or silting whatever in channel.

STOCK PONDS IN THE GREAT PLAINS DROUGHT AREA

By W. C. Lowdermilk [1] and F. F. Barnes [2]

Farm reservoirs were empty. Tracks in the dried mud bottoms mutely told of the vain search of thirsty cattle for water. Out of scores of reservoirs in western Kansas inspected during the drought of 1934, only one was found capable of moistening a parched throat. In normal times these basins—whether man-made or natural—supplied water for the farm stock, but during the drought their bounty quickly disappeared and it became necessary to rely on wells for both man and beast. Here, too, the reserves were rapidly exhausted, and serious shortages ensued.

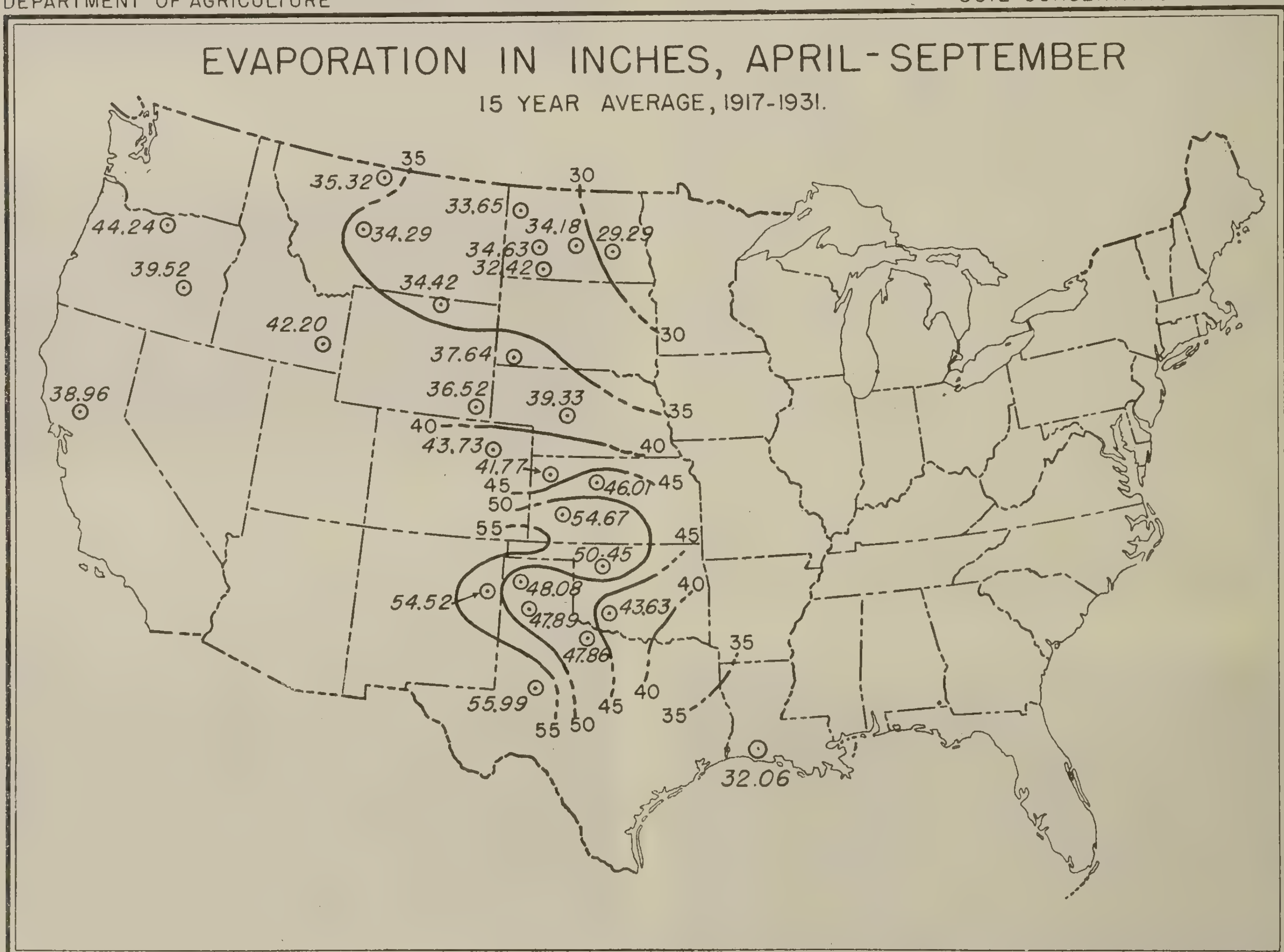
There is a definite relationship between soil conservation and water conservation. An examination of many of the dry ponds by the senior author disclosed a few simple facts which had been overlooked in their location and design—considerations which, accorded proper attention, would have assured a supply of water during the urgency of drought.

Evaporation Overlooked

It was first apparent that the evaporation loss from a free water surface during the warm season had been overlooked in the design of the now-waterless reservoirs. The draft on a reservoir for livestock in the Plains is a small fraction of the evaporation loss. Without evaporation loss an acre-foot of water will water for a year 100 head of stock requiring about 10 gallons per head per day. But evaporation loss from a free water surface would be 4 to 5 feet from April to October—five or more times the water requirements

[1] Associate Chief, Soil Conservation Service.
[2] Division of Research, ibid.

DEPARTMENT OF AGRICULTURE — SOIL CONSERVATION SERVICE



HORTON AND COLE
MONTHLY WEATHER REVIEW, MAR. 1934

BUREAU OF PLANT INDUSTRY RECORDS.
15 YEAR AVERAGE, 1917-1931

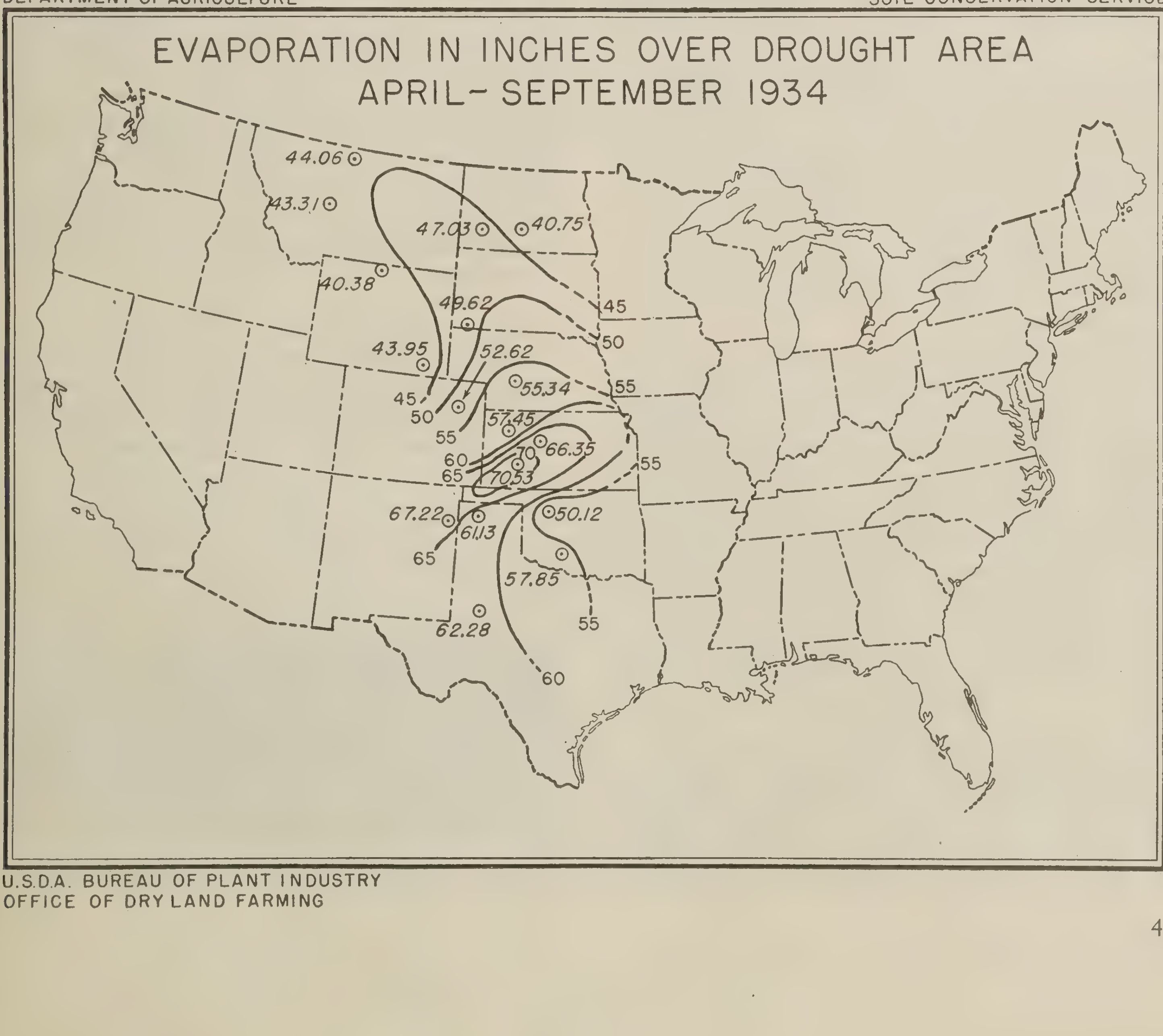
of stock. Unless the stock reservoirs or ponds were deep enough to allow for evaporation losses, it mattered little as to their total capacity—when dried by drought. As a general rule, a depth of double a season's evaporation loss would be a safe provision. Other considerations must likewise be had in the design and location of farm reservoirs or ponds. These will be more fully enumerated below.

A Timely Demonstration

The disastrous drought of July 1936 in the central and northern Great Plains emphasized the need for immediate action in providing adequate water supplies for livestock and other farm purposes. One of the most effective means of combating the tolls of drought is the construction of widely distributed and properly designed small reservoirs and farm ponds, which will store run-off from storm waters for use during prolonged dry periods. **Great material benefit is being derived from approximately 350 such reservoirs constructed in North Dakota, the heart of the drought area, between 1933 and 1935 by C. C. C. camps.** It is anticipated that this program will serve as a demonstration of the value to be derived from the widespread construction of such storage basins wherever natural conditions will permit, and that farmers in all sections of the affected area will aid in extending the work.

The cheapest and most practicable type of reservoir in most cases is formed by constructing an earthen dam, which may be built directly across a drainage line or may enclose an artificial depression to be filled by a diversion ditch or pipe line from a natural stream or drainage way. The cost of such reservoirs varies widely with the size and with local conditions. **For the program in North Dakota $150 per acre-foot (325,850 gallons) of storage space has been set as the maximum cost allowable. Most of the cost, however, represents labor**

DEPARTMENT OF AGRICULTURE — SOIL CONSERVATION SERVICE



U.S.D.A. BUREAU OF PLANT INDUSTRY
OFFICE OF DRY LAND FARMING

One of the few ponds in Kansas that did not go dry during the season of 1934.

and equipment which the farmer himself is usually able to supply. Investment of his spare resources in pond construction during slack seasons will frequently be more than offset in a short time by savings from stock losses during droughts.

The success of any reservoir depends on the use of approved methods of design and construction of the dam and spillway to insure against excessive leakage, to reduce maintenance requirements, and to make ample provision for the handling of overflow water without washing out the spillway or dam. Detailed specifications and many helpful suggestions may be obtained from the United States Department of Agriculture, Department Bulletin No. 1358, and Farmer's Bulletin 1703, S. C. S. Handbook of Water Conservation and Erosion Control Measures for Region 9, and Montana Agricultural Experiment Station Bulletin No. 301.

Too much emphasis cannot be placed on the necessity of providing ample spillways, particularly for reservoirs located in stream channels. The spillway is as important to the success of the reservoir as the dam itself. Most failures of dams may be traced to inadequate spillways. The size of spillway required may be approximated by estimating the average cross section and water-surface slope of high-water channel from high-water marks on trees and lines of drift at several points upstream from the proposed dam. Frequently high-water marks are not visible so it is necessary to use approximate run-off formulae or curves.

Many other factors need to be taken into account in locating, designing, and constructing small reservoirs in order to provide maximum storage in critical dry seasons. Perhaps the most important of these factors are evaporation losses and seepage losses. Evaporation losses are particularly vital in regions of low humidity and high temperatures as typified by the drought country, and are commonly overlooked in planning reservoirs.

Annual Evaporation Figures

Data collected in various parts of the Midwest by the Bureau of Plant Industry show that the annual evaporation from water surfaces from April to September averages around 30 inches in the eastern Dakotas, 50 inches along the Kansas-Oklahoma boundary, 45 inches in southern Oklahoma, and 55 inches in central Texas. These averages may be exceeded by 50 percent during drought periods. Since these figures greatly exceed the run-off of storm waters in the respective regions, it is important that steps be taken wherever possible to reduce loss by evaporation.

The reservoir may be located so that trees or steep slopes shelter it from hot dry winds, and, if possible, the long axis of the reservoir should be selected to lie crosswise to the prevailing winds. Under all conditions, however, the most effective means of reducing evaporation losses is to construct reservoirs with a minimum area of water surface for a given storage capacity, since the rate of evaporation is proportional to the area exposed. **The ideal basin from the standpoint of evaporation, therefore, is narrow and deep. Records of southwestern reservoirs show that those over 12 feet deep go dry much less frequently than shallower reservoirs.**

Deeper Reservoirs Favored

Reservoirs should be constructed so that the depth will be greater than the maximum possible evaporation above the use draft. Where there is a choice of natural sites, dams should be built across narrow, steep-walled valleys, and reservoirs constructed by excavation should be made narrow and deep, but not so steep-sided that the walls and sides may not be made watertight by methods described below.

Old pond nearly full of sediment due to silt washing down from cornfield above.

A second important factor to consider in locating and designing reservoirs is loss of water by seepage. Experience has shown that loss from seepage is even greater than that from evaporation unless careful measures are taken to prevent the water from percolating away through the ground. This is best done by choosing a site underlain by clay-grit, a compact mixture of about one part of clayey material to two or three parts of sand and gravel. Such a soil is more watertight and substantial than pure clay, and, fortunately, is common over wide areas of the Plains. If the site is to be excavated, which is often desirable to obtain greater depth, the clay-grit should preferably be thick enough to allow for the excavation without exposing either a fissured bed rock or, what is more common in the Great Plains area, porous beds of sand and gravel; or, if the clay-grit is not thick enough for this, the bottom and sides may be surfaced with suitable material of excavation.

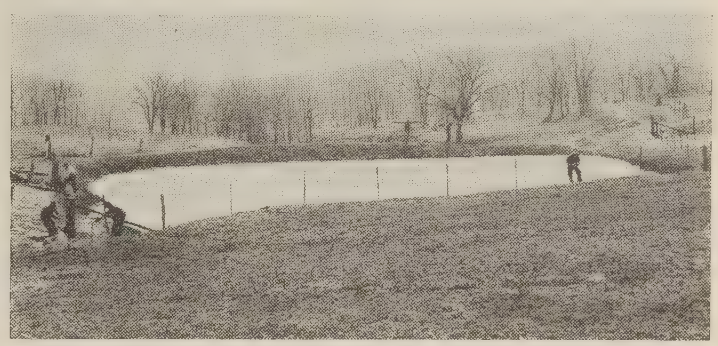
Reducing Seepage

Seepage in a new reservoir is reduced by plowing up the strip on which the dam will rest to secure a good bond, and by packing the earth-fill thoroughly during construction of the dam. If the fill is not composed of suitable materials, a clay-core wall, extended well into impervious material, should be provided in the body of the dam. The bottom of the basin should be packed thoroughly. If the water is not to be used for domestic purposes, the best method of packing the bottom is by bedding or feeding stock on the reservoir site when the earth is wet.

Marked success in reducing seepage losses has attended the use of bentonite, a form of clay which swells very greatly upon wetting. Deposits of this material occur in several of the Great Plains States. The bentonite is dusted into the water above the point of leakage, and is quickly drawn into the pore spaces of the underlying soil to form a watertight layer.

The size of the watershed above the reservoir site should be sufficient to provide ample water within the limits of climatic conditions. In the Plains area of Montana and Wyoming, 3 square miles of drainage area for each acre-foot of reservoir capacity is desirable to secure a stable water level. In the Dakotas, the figure is 1½ square miles. On the other hand, the area should not be so large as to offer a constant flood menace to small dams such as are constructed. In general, the farther downstream a reservoir is from the headwaters the greater is the likelihood of damaging floods.

Watersheds or catchment basins that are overgrazed or otherwise subjected to gullying and sheet erosion should be avoided until amply protected by a new growth of vegetation, for a reservoir fed by such an area would soon be filled with eroded soil from the slopes above. Since a certain amount of erosion occurs, even under normally favorable watershed conditions, steps should be taken to retard the filling of the reservoir with mud. Possible measures include: (1) Reduction or abandonment of grazing or tillage in the drainage basin, which may be held as emergency range or pasture. This is done most effectively by fencing both the reservoir and the watershed, and providing stock-watering troughs below the dam. (2) Settling basins, grassed waterways, or check dams upstream from the reservoir. These stop the sediment before it reaches the main basin. (3) Location of the reservoir to one side of the main channel and filling it from a diversion ditch or pipe line. In this way a flood gate in the feeder can be opened during floods to prevent the mud-laden water from entering the reservoir.



Earthen dam built to control large active gully. The fencing is to prevent possible damage by stock. The 300-foot spillway carries overflow water to a well-sodded, slightly wooded slope outside the original gully.

Other considerations in the choice of a reservoir site are the ease of access to stock, the possibility of satisfactory location of troughs, corrals, and other structures below the dam, and the size and cost of the dam required to give the desired storage. The largest capacity for a given size of dam is obtained in a basin that is narrow at the dam site and has a nearly flat slope above the dam.

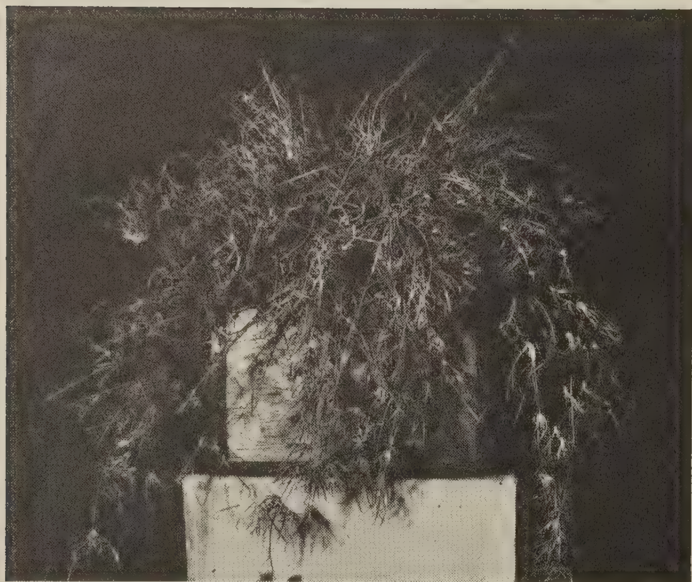
Needs of Livestock

Once the site is chosen, the size of reservoir needed will depend on the water requirements of the livestock to be watered, the period of dependence, probable frequency of filling, loss from seepage and evaporation, and danger of reduction in capacity from silting. The

(Continued on p. 58)

A CLOSE-UP OF BUFFALO GRASS, NATIVE OF THE GREAT PLAINS

By Guy C. Fuller [1]



A single plant of buffalo grass.

No exotic or indigenous species of grass has been found more fully adapted to the heavier soil types of the western Great Plains area than buffalo grass (*Buchloe dactyloides*).

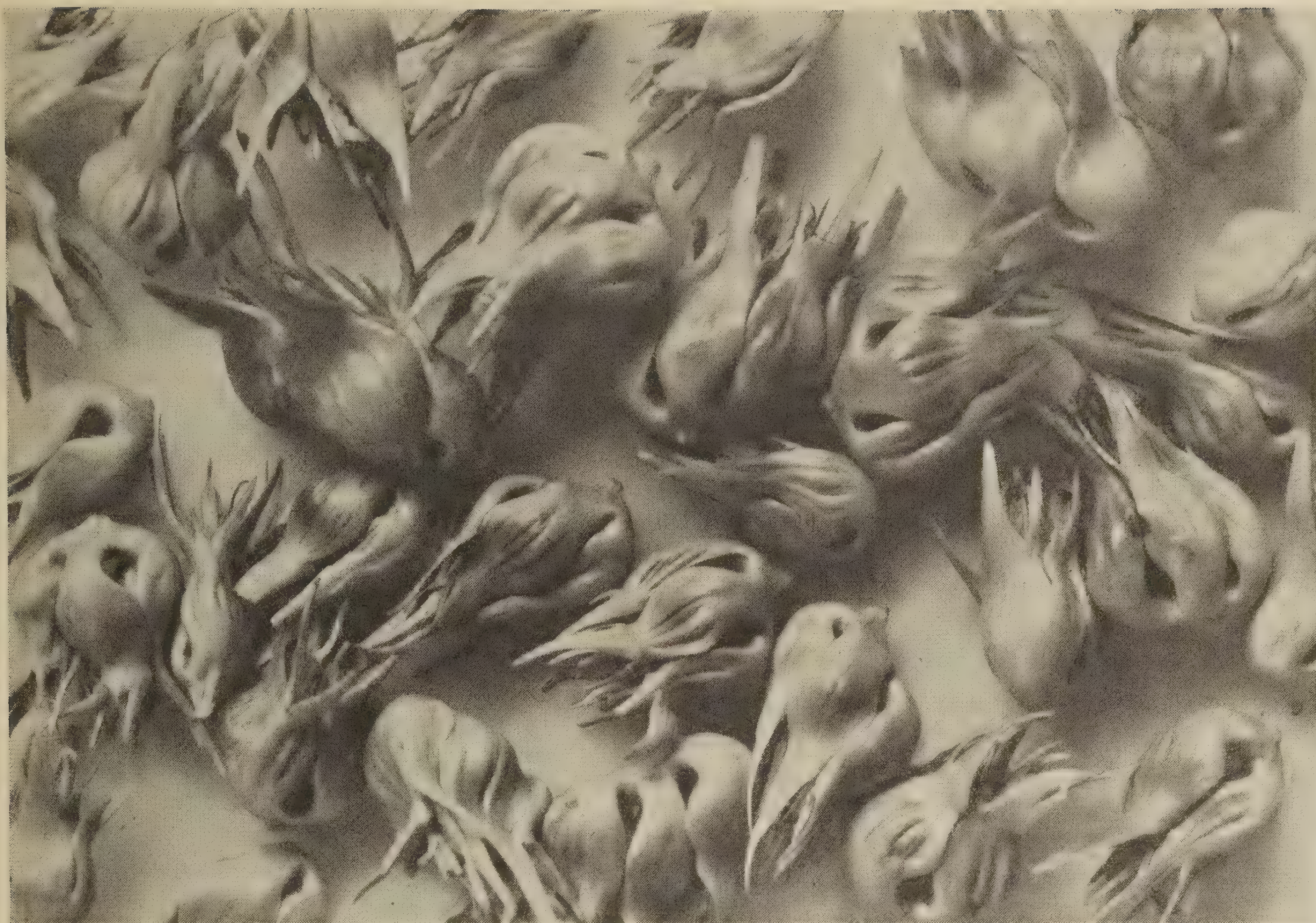
It may be noted, parenthetically, that the Soil Conservation Service has been in operation for a sufficient period of time to determine that vegetation, in most cases, is the most effective and economical weapon to employ for combatting soil erosion and for conserving moisture. Attention is being focused upon the use and development of those vegetative types most effective in soil and moisture conservation and possessing, also, the greatest economic value. It may be observed, further, that the vegetation for use in the more humid regions is far more numerous and varied in kind than that available and adapted for use in the drier regions. These facts emphasize the necessity of exercising greater care in the selection and planting of all material to be used in the drier regions, if any degree of success is to be attained. The grasses have proved to be the type of vegetation best qualified for all around use in the conservation program.

Throughout the western Great Plains, where duststorms have been making history and where crop failures have occurred year after year, a vegetative cover is sorely needed and insistent demands for buffalo grass are heard. From the standpoint of erosion control, palatability, nutritive value, and ability to withstand extreme conditions on the heavier soil types buffalo grass is without a peer. It is hoped that by pointing out some of its valuable assets a greater number of people will become acquainted with some of the interesting facts concerning this valuable plant.

Adaptability.—Buffalo grass may be found from Texas to South Dakota and from the ninety-eighth meridian west to the foothills of the Rocky Moun-

[1] Associate agronomist, Soil Conservation Service.

Buffalo grass forms a dense mat, if not mowed or grazed.



Burs produced by female plants (× 5).

tains. It is particularly well adapted to the heavier soil types.

Economic value.—Under a wide range of conditions buffalo grass will yield at least as much forage as any other grass throughout its range. It is highly nutritious and palatable during all stages of growth and even when it is dry and brown.

Type of growth.—Buffalo grass under favorable conditions will reach a height of from 3 to 6 inches. It is a stoloniferous long-life perennial, sending out runners which root at the joints and send up new plants. It is dioecious (produces both male and female plants). The blades are fine, numerous, slightly pubescent, having a tendency to curl, forming a very dense top growth.

Seed habits.—Seed, or small burs, are produced by the female plants on the stems near the surface of the ground. The burs are composed of one or more parts, usually two or three, each of which may or may not contain a caryopsis. The bur, or coat surrounding the caryopsis, is composed of a tough fibrous material which is no doubt a protective covering for the small seeds during periods of extreme conditions such as

Seed or caryopsis removed from the burs (×5).

often prevail where buffalo grass is native. Seed, or burs, do not mature uniformly like seeds of other native grasses, but are produced throughout the season during growth. This would indicate that har-

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The Soil Builder

By Angus McDonald [1]

OUR farm [2] was one of the poorest and hilliest in eastern Oklahoma. The old man [3] called it his rock and air farm.

The old man was a fanatic. He was a fanatic on soil conservation. He was always telling his neighbors how they should plow their crops and they were always laughing at him. They laughed at him because he was a preacher and he was telling them how to farm. He had queer ideas about the way to plow in dry weather, about hillside plowing, about building dams in the gullies and draws, and about conserving the soil in other ways.

The old man was a fanatic about the land. He was aways talking about Jefferson and his great agrarian philosophy of government and about Jefferson as conservationist.

"The soil," the old man said, "is the backbone of the Nation. If the soil washes away the country will go to rack and ruin."

The old man built dams all over his washy hillsides. One of the neighbors said, "The old man is the damnedest dam builder in the damn country."

I remember the old man built his dams very carefully. He would instruct the hired man how to place the rocks, and then, after the dam was built, tear it out and build it over to suit himself. He would put a rock in place, "hist" his foot on the wagon hub and give us a lecture on the soil. "When the soil is gone, the country will go to rack and ruin." Then he talked some about Jefferson and then some about Scotch contour plowing. But nobody listened. What was the use, when we had heard it so many times.

His Method

"You must always make a solid wall of rock across the gully", the old man said. "Fit the rock together and use the big ones first. Then back of the wall put the small rocks up the hill as an approach. For a small gully a 2-foot approach is enough. The little rock should be filled in until they are almost level with the top of the rock wall. Then heavy gravel or fine rock should be spread over the approach as a finishing coat."

We often tried to slight our work and throw the rocks in any way. But he would see us and make us do it over again. Will said that the old man watched us out of the corner of his eyes so much he was going blind.

The old man used a peculiar kind of hillside turning plow which he had invented or gotten somewhere. I have never seen one like it. There was a bolt and slide which turned the blade so that in turning land he could come back in the same furrow without going up and down the hill.

Aerating the Soil

Frequently when breaking land the old man used what he called a subsoiler. He ran this in the furrow behind the turning plow. A long keen bull tongue was attached to a Georgia stock. He said that this let the air get down into the soil better.

"Cotton," the old man said, "has ruined the South. It has impoverished both the land and the farmer. I am proud," he said, "that I have never raised a stalk of cotton."

The old man believed in raising lots of feed crops, particularly legumes and keeping plenty of stock to enrich the land with their manure. He

[1] Assistant soil conservationist (erosion history), Division of Climatic and Physiographic Research, Soil Conservation Service.

[2] Located near Sallisaw in Sequoyah County, Okla.

[3] The old man was Dr. J. A. McDonald, a Presbyterian minister. He was born in 1850 in Alabama, reared near Tupelo, Miss., educated at Coopers Institute, Mississippi, and at Lebanon, Tenn. He was not a professional farmer, never farmed except when he lived on the farm referred to here (1912–1922). As he read widely he probably picked up his ideas in various places. However, I have heard him say that some of his ideas had been in practice in the family for generations.

said that the farmer who bought his feed was a disgrace to civilization. The farmer should raise everything he eats except sugar and coffee.

All the farmers around let the ground near the fences and in the corners go to waste. He used every square foot of his land. He said that the richest soil was next to the fence because it had never been abused by agricultural butchers.

To begin with, our farm was one of the poorest and hilliest in the country. "You can't raise corn on that land," the neighbors said. "Maybe not the first year but you wait. I'll build it up." "What do you mean, build it up? That land is 'pore' and thin," the neighbors said.

Well, the old man went on building his dams and after 2 or 3 years, the neighbors admitted his crops were better than theirs.

Soil Feeders

On the very thin land that had much slope he set out Bermuda grass. On all the cultivated land he planted cowpeas, peanuts, and other crops that he said would enrich the soil. He never laid by his corn without sowing cowpeas unless he already had them in rows between the corn. About the next to the last cultivation sometimes he would put a row of peas in the middle. On especially thin land I've seen him plant alternate rows of peas when he planted corn. The corn rows would be 8 or 9 feet apart and have one or two rows of peas between.

He rotated his crops a great deal. His land never had corn on it more than once in 3 years. He had it all figured out that he would put more into the soil than he took out. He was the only farmer around that got two crops a year off his land. We sowed oats in February, harvested in June, and the old man, no matter how dry it was, would always break the ground as soon as the stock had cleaned up the waste grain. Then he would plant cowpeas or some other leguminous crop.

He was always cultivating in dry weather. He said that it helped to hold the moisture and the ground would soak up more and there wouldn't be so much run-off if the ground were broken.

The old man claimed the reason he made such good yields of corn was because he plowed it every 8 days in dry weather. All the old farmers waited for a rain before they plowed. They laid by their corn when it was about waist high but I've seen him cultivate his twice after it was in silk and tassel. The other farmers laid by their corn with solid sweeps that cut the roots but he began using buzzard and open sweeps after it was up any height at all. The big buzzard sweeps that he used on a double shovel stock to lay by with hardly stirred the ground over half an inch deep.

His Theory

He had a theory about conserving the moisture which took him about an hour to explain. I remember that I used to talk to Will when he got started on it but the old man was deaf and never paid any attention. He said that the capillary continuity must be broken to keep the soil from drying out.

There were only 20 acres in the old man's original farm. I remember he had rock walls nearly all around his land. These weren't gully dams; they were just walls around the fences. I remember one side of his farm was about 3 feet higher than the land next to it. The old man used to stand by the wall and look down upon the adjacent 10 acres. There was a big gully that seemed to start from nowhere just below our land. There weren't any gullies on our side at all. Just two long slopes that ran together and formed a draw in between. About every 100 feet up the draw there was a rock dam. The silt and sand had filled in above the dams until it was 6 or 8 inches higher than below.

The old man used to stand and look at that big gully below our land. He always seemed to get angry when he looked at it. The gully was 5 feet deep in some places, I guess. It ran about 50 yards from the edge of the 10-acre field. The

(Continued on p. 58)

CHOOSING THE RIGHT TREE[1]

By A. E. Rupp[2]

This once spectacular gully in Illinois illustrates extreme fundamental change in site conditions since original climax forest.

Up to this time the Soil Conservation Service has planted approximately 400,000,000 trees and shrubs on more than 200,000 acres of eroding land—a substantial contribution to the program of soil and water conservation.

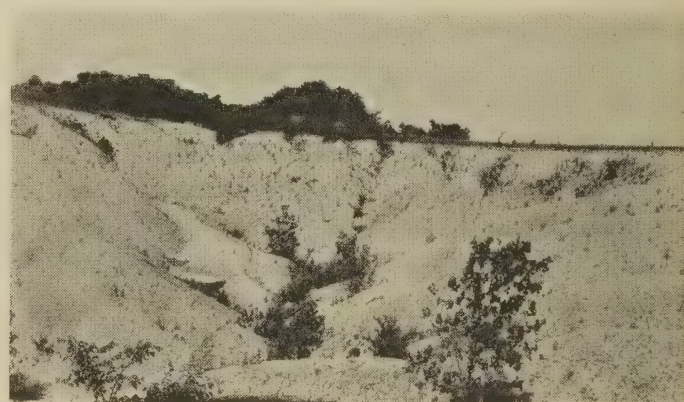
Tree-planting, whether on a large or a small scale, is not simple. And an achievement of such great magnitude as this necessarily involves a multitude of factors and problems, not the least of which is the selection of species.

Cultural practices which permit uncontrolled washing of sloping lands have transformed hundreds of thousands of once-fertile acres into eroding wastes. Here the productive capacity has been greatly impaired, if not entirely destroyed. Afforestation appears to be the most feasible means of restoring soil productivity, through the process of building up organic matter.

Conditions on much of this land are such that the "climax" type of vegetation will not establish itself without cultural treatment and the application of nature's law of succession. The forester must be an ecologist if he is to understand the changes wrought by nature and by man upon the countenance of the landscape. The restoration of higher types of vegetation is the reverse of what has happened under the destructive hand of man.

Dr. F. E. Clements states:

> The solution of all problems that involve natural vegetation directly or indirectly rests upon the fact that every plant or community is an indicator of the conditions about it and hence of the causes that lead to these. However, the judgment of many individuals is more dependable than that of one and the verdict of many different kinds of plants grouped in a community is much better. In consequence, the study of the chief societies of a region affords the best measure of the climate and its possibilities, while the minor ones will reveal the significant variations of soil and topography.
>
> When disturbance takes a hand, these primary indications may be greatly modified and the pattern becomes much more complex. Nevertheless, such mosaics can be disentangled by careful scrutiny, and the respective parts ascribed to climate, soil, or human interference. In a program of rehabilitation, the effect of the latter are of the most immediate importance, but they can be turned to account only as the indications of climate and terrain are understood and heeded.
>
> Fortunately, plant communities not only reflect the controlling factors, but also the sequence in which changes occur, from which is derived their greatest value in human situations. They indicate not merely previous conditions and communities, but they also forecast what will happen in the future and hence serve as the basis for control of all kinds and furnish the most satisfactory method of determining the best use of land.



Erosion arrested by bank sloping and tree planting.

Final Evaluation

The correct determination of species and cultural practices is basic to successful afforestation and will necessarily be evaluated finally by the number of living trees and the improvement of conditions conducive to soil and water conservation.

The proper appraisal of site conditions and site requirements for the species to be used is essential. It will rarely be possible to plant the climax species on the badly eroded or "problem" sites and, unless cultural treatment promises to ameliorate the adverse site conditions, we must resort to other species chosen on a basis of prevailing site conditions and tree requirements.

Afforestation has several objectives: To arrest soil losses, to conserve water resources, to restore humus and fertility, to increase farm income from trees and

[1] This is the third in a series of articles.

[2] Forester, Soil Conservation Service.

shrubs, to furnish cover for birds and animals, and to establish proper land practices.

Build Own Soil

The establishment of tree growth on eroded land will stabilize soil and thereby arrest erosion, and create woodland that will build its own nitrogenous soil.

If the soil had been left to nature and withheld from the human hand, it would have remained covered with vegetation which would have kept the soil stabilized. In the planting of trees to develop vegetative cover man cooperates with nature to stimulate and accelerate the normal work of plant life. All local factors such as elevation, exposure, the number of cloudy and clear days, the quantity and distribution of rainfall, the intensity and duration of sunlight, the clarity of the atmosphere, and the direction of the winds, must be carefully determined.

Soil Conditions

Conditions of soil must be given similar consideration. Some of these concern the physical and chemical characteristics of the subsoil. Others, such as hygrological conditions and the thickness and structure of the fertile surface soil, are based upon the topography of the soil and its geological nature. The study of site conditions leads one to a solution of the most essential part of the afforestation problem, the choice of species.

An examination of the natural local flora offers a useful aid. The disturbance of the forest by man usually leaves on the ground visible evidence of the primitive plant association which constitutes the nucleus from which new vegetation starts and spreads. This new vegetation, like the old, struggles against unfavorable factors and, by overcoming them gradually, reacquires the typical local form. We are thus able to estimate the state of degradation to which the plant association has been reduced, a state which faithfully reflects the condition of the soil. It also reflects which plants are best suited to the site in question, and the relative condition of soil fertility.

One year later. Black locust demonstrates its usefulness in rising to the challenge of such a situation.

Often Necessary to Start Over

The natural flora may indicate a serious dearth of fertile soil, of humus, of hygroscopic water, of nutritive matter, constituting a state of physiological poverty. Under such circumstances we would commit a very serious error if we should immediately attempt to plant the same species that once thrived in the locality. Such areas lack the important humus layer. Not only the trees of the former plant association have been destroyed, but also the shrubs and perennials. It is, therefore, a matter in such cases of reconstructing the whole flora, beginning with the establishment of the forest humus by the use of those trees and shrubs which are the pioneers of the climax forest.

Every climatic zone has in its flora at least one certain species suitable as temporary or preliminary vegetative cover on the poorest soils. Among shrubs, the number of species is much larger. The species, as is to be expected, may have little commercial value but they do prepare the way for the subsequent reestablishment of a climax type of forest.

Each individual case must be studied and solved separately. Although experience teaches us that on sterile soils temporary woodland is the usual prerequisite to permanent woodland, we know that where the vegetative cover is still sufficiently thick and shows a certain quantity of humus, it is possible to undertake the direct planting of the final woodland over part of the area, if not all.

Generally speaking, we have made surprisingly little progress in establishing methods of analyzing site conditions and in the selection of suitable species for planting. The problem largely remains one for research and experimentation, but the time factor urges us to pool all available local information for purposes of immediate application.

Proof that grass holds soil and saves water was demonstrated by actual measurements taken by erosion experiment stations at Tyler and Temple, Tex., after intense rains.

Soil was swept away from a cotton field at the rate of 63 tons per acre; 31 percent of the rainfall was lost as immediate run-off, while on an adjoining field of grass only three-tenths of 1 percent of rain was lost. A field planted to Bermuda grass lost soil at the rate of only 60 pounds per acre and less than 1 percent of the rainfall run off.

THE CALIFORNIA BARRANCA

By Harry E. Reddick [1]

Barranca is the Spanish word for gully. Citizens of southern California have continued to use the word for the same reason that their real-estate men call a 10-acre plot a "rancho." Calling a 10-acre chicken-run a "rancho", or sometimes, modestly, a "ranchita", has a marked tendency to loosen the purse strings of newcomers, and one has only to look at the subdivision flags in and around Los Angeles to appreciate the psychology that has sold many a homesite in a gully with the tongue tickling nom de plume "barranca."

First Erosion Task

The California project's first task was to conquer a veritable clan of these barrancas. And it may truly be said that the arrogance of these barrancas was in full accord with that of the Spanish grandees who once lived on the land they now attack.

The royal grants that included the area now known as Las Posas often had boundary descriptions that bespoke the subtle poetry of life in carefree days. "From mountain peak to mountain peak and from Heaven to hell," read one such description, at the time when scattered fields of corn, grapes, and olives, marked the hospitable haciendas along El Camino Real, where now the price of one single acre of oranges or walnuts exceeds the value of a square league then.

[1] The author is regional conservator of region 10, Soil Conservation Service.

Originally Not Gullied

The Las Posas project contains, roughly, 30 square miles lying along the base of the foothills, some 10 to 12 miles inland from the Pacific Ocean, between Santa Barbara and Los Angeles. All evidence indicates that up until 50 years ago it was a rich, alluvial plain, where stockmen could travel miles on end without once encountering a depression of sufficient depth to hide a rider on a horse. The soil was rich, unusually deep, and covered with a dense growth of sage, or in the spring with a quilt of yellow and gold patchwork, where the mustard grew head high, or myriads of wild poppies painted the slopes.

Climatically, it was considered a part of the great southwestern desert, fit only for stockraising, with occasional fields of beans, corn, or chilies on the outskirts of a peon's adobe home. It is a region where the average rainfall is less than 14 inches, 90 percent of which falls during the 4 winter months from November through February. To say that it never rains before or after these months would be an error, but to say that it is likely to would identify one as a new-comer. This was the picture when the empty-pouched and disillusioned gold seekers of the late fifties bought plows, and returned to the tilling of the soil to make their fortunes.

High Valuation

Today the Las Posas project of approximately 20,700 acres has an average value of $626 per acre, and that does not make allowance for the fact that approximately 8,000 acres, or 40 percent of the included area, is too mountainous for agriculture.

Slashing down through the lower, more productive slopes are no less than 11 of these barrancas, with widths frequently exceeding 100 feet, and depths frequently exceeding 75 feet—11 huge cracks that crease the surface of the land in less than 12 square miles of area.

What have 50 years of agriculture and 50 years of growing barrancas done to this one locality? Fifty years of modern agricultural methods have changed this land from one of semidesert, devoted largely to grazing, to an extremely rich agricultural community where prosperous farmers grow lima beans, English walnuts, oranges, and lemons on land that pays a 10 percent dividend on an average value of $1,500 per acre in the tillable areas.

Barrancas Work Fast

The barrancas, however, have kept pace with the rise of agriculture. The barranca family of Las Posas has actually taken out of cultivation 775 acres of land with a total value exceeding $775,000, and is certain to take soon, if not stopped, an additional 525 acres worth $525,000. With but 4 months of each year to make use of run-off from the fields as a destructive force, this barranca family, starting from scratch 50 years ago, has bodily removed and transported from this one area alone an amount of dirt equal to a canal 18 feet deep, 50 feet wide, and 25 miles long.

One acre out of every 15 of the agricultural land in this area has been turned over to ground squirrels, gophers, and other rodents that wax fat on the crops along the banks. Eleven great ditches have sapped the moisture from the fields where moisture is always at a premium. This is the criminal record of Senor Barranca and his clan in but one California community.

View of once worn-out hillside on Freund farm, taken during period of drought in June 1936. In foreground may be seen orchard trees and meadow, interspersed with strawberries and garden crops. Through the center run rows of grapes and beyond them corn, alfalfa, oats and corn, berries, alfalfa, oats, alfalfa in strip arrangement.

FIFTEEN YEARS OF SOIL-BUILDING

A lot of Ohio farmers have waited for the Soil Conservation Service to point out basic principles of saving the valuable topsoil on their farms, but this is not true of Karl Freund, Belmont County. About 15 years ago he adopted soil-saving and soil-building practices on a worn-out hill farm. As a result, his land is much better today than it was 15 years ago.

Although he follows practices recommended by the State Extension Service, Freund brought some of the same ideas from Germany, from which he emigrated a decade and a half ago. Among the methods brought from the Old World are strip-cropping, liming, fertilizing, and rotation. By following these practices the Freunds have been enabled to improve upon their original investment and to purchase an additional tract of hill land for pasture.

"This farm wasn't much good when we came here", Carl Freund, the son, explained. "Those hillsides wouldn't grow much. The only good land on the place was that little piece by the barn", and he indicated a one-tenth-acre garden patch. "But look at the slope there now", he continued, waving toward a sizeable hillside, growing luxuriantly to strips of alfalfa, oats, corn, and berry patches, "it will grow anything."

One secret of rebuilding their 33-acre farm lay in proper manuring and liming. The Freunds quarry limestone on the farm and burn it in a specially constructed kiln, quite unlike the usual method of burning in beds. This idea came from the old country, as did Freund's confidence in strip cropping, which enables him to prevent loss of soil and water through erosion on steep fields.

A CLOSE-UP OF BUFFALO GRASS

(*Continued from page 49*)

vesting should be delayed until late in the season if the maximum yield is to be obtained.

Germination.—Results from germination tests have ranged from zero to 95 percent, depending upon the methods used. When the caryopsis is removed from the bur, a higher and more rapid germination takes place. Burs planted in soil and subjected to chilling over a period of 30 days have given 67 percent germination.

Harvesting of seed.—Seed has never been harvested in quantities, and no accurate information is available on yields per acre or cost per pound of harvesting. In the spring of 1935 the Soil Conservation Service recognized the value of this particular species and a determined effort was made to devise a means of obtaining seed in quantities, and of gathering information on yield per acre and cost of harvesting. The seed being produced so near the surface of the ground and the fact that it drops to the ground upon maturity, presented a real harvesting problem. An experimental vacuum machine was designed for the purpose of harvesting seed of this grass, a description of which appeared in the January 1936 number of SOIL CONSERVATION. Experimental information indicates that this method of harvesting seed may become economically feasible.

Vegetative plantings.—As previously pointed out, buffalo grass is stoloniferous, which makes it possible to establish the plant vegetatively. Under favorable conditions it will spread quite rapidly, eventually covering large areas. The rate of spread depends upon many factors—size of cubes used, soil types, degree of fertility, moisture, competition with weeds and other plants, temperature, whether or not the grass is cut, grazed, or injured by the tramping of livestock.

This Farmer Looked Ahead

The possibilities of establishing a sod or of obtaining a vegetative cover upon a cultivated field may best be indicated by citing an example. In 1930, and that was before the establishment of the Soil Conservation Service, a farmer in western Kansas wished to establish a buffalo grass pasture in a field near his barn that had been cultivated for a number of years. He took a plow and made furrows across this cultivated field approximately 10 feet apart and 5 inches deep. An old, little used township road ran along one side of the farm and buffalo grass had overgrown it. This farmer, with the help of a boy, plowed out long strips of sod, approximately 12 inches wide and 4 to 5 inches thick, cut the strips into squares, hauled them to his furrowed field and dropped them in the furrows, 12 to 15 feet apart. The square sods were not rolled or pressed into the ground but loose dirt was banked around the edges of each square. This farmer with the help of the boy, spot-planted 10 acres in one farmer's-day. The field was ungrazed for 2 years, and stolons emerged from each side of the sods, gradually filling in and covering the broad intervening spaces. So promising were the results after 2 years' observation that the farmer increased the plantings to 25 acres. In spite of the fact that favorable growing conditions have not prevailed for any long periods of time since the sods were planted, this farmer now has obtained almost a complete cover. Today he can boast of 25 acres more buffalo grass—the kind he desires most of all for his livestock. Many farmers now possessing a small acreage of buffalo grass could very well profit by this experience. They would not permanently damage their pastures because the area from which the sods were removed would soon recover itself under a brief period of favorable conditions.

There are arguments for and against such practice but this specific example illustrates what can be done, for the benefit of those who wish to attempt such a practice upon a small scale.

One other possibility is that of obtaining seed and using it alone or in mixtures with other native species for the purpose of getting it reestablished and providing a good vegetative cover. As most of us know, the south-central Great Plains, and especially the Dust Bowl, have been blessed with several good rains, reaching flood stages in some instances, while the north-central Great Plains are experiencing the worst drought in history. With these several good rains coming in the south-central Great Plains, another practical example is in order.

In Deaf Smith County, Tex., which is almost centrally located in the dust region of the Southwest, comes the following report:

In 1931 a farmer plowed up his buffalo sod and seeded wheat; the same field was put into wheat in 1932 and again in 1933. In 1934 the seed bed was prepared but the wheat was not planted. In 1935 half of the field was prepared for wheat but not planted. In May 1936, by actual count of plants in given units of ground, an average of 15 plants per

square foot was indicated, 25 percent of which were buffalo plants coming from seed.

We know comparatively little about our vegetation, especially our native grasses. Most of our commercial plants are introductions, and some very excellent types of vegetation are being sent to us each year from away, but here is buffalo grass, native to the Great Plains, and it meets all the requirements for erosion control. Demand for it is greater than for any other species. It is more persistent and will survive under extreme conditions and rough treatment. Once established, it is better than any other native grass throughout the range of its adaptation.

Seed requests for buffalo grass have outnumbered those for any other species. This alone should be sufficient evidence of its value. Seed is not yet available and substitutes must be used for the present. However, in the light of recent developments, the time is not far distant when this grass may be reestablished successfully on the heavier soil types in the Great Plains.

For additional experimental information, the work of D. A. Savage, agronomist, Division of Forage Crops and Diseases, United States Department of Agriculture, is cited in Circular No. 328, Methods of Reestablishing Buffalo Grass on Cultivated Land in the Great Plains.

WITHSTAND POUNDING

(*Continued from page 43*)

great amount of water being concentrated in streams so rapidly that all of it cannot be carried off normally. While erosion-control measures cannot be expected to hold all the rain where it falls, it is not unreasonable to believe, thinks Mr. Du Puy (and there is experiment-station data to support his judgment), that if all the land in a watershed area were under an intelligent erosion-control program, sufficient water would be held out of the streams, or fed into the streams gradually, that flood hazards would be greatly lessened.

Other erosion-control projects in Texas are located at Garland, Temple, Lindale, Nacogdoches, Mt. Pleasant, San Angelo, and Dublin. There are, in addition, 27 soil conservation C. C. C. camps in the State.

After seeing at first hand the manner in which erosion-control measures on farms in the Plum Creek project area protected the land from washing and cutting under almost unprecedented rainfall, I am convinced of the practicality and vast potentialities of the Soil Conservation Service which has pointed the way so clearly here in Texas.

STILL USEFUL AFTER 75 YEARS

There is a perfectly sound black-locust fence post on the Jarrell Jarrett farm in Jackson County, Ga., that has been in use more than 75 years. Before the Civil War the post was cut and set and a gate swung on it for years.

Still well preserved, the post today continues to serve a useful purpose in a woven wire fence.

Grows Rapidly

One of the fastest-growing hardwood trees, black locust is used extensively by farmers cooperating with the Soil Conservation Service in the control of erosion. Planted in gullied areas or on unproductive land where the topsoil has been removed, the trees are of help in preventing further damage from washing.

Under favorable conditions, the locust grows rapidly and yields durable fence posts in 10 or 12 years. Trees 30 feet high and 5 inches in diameter are often grown in 15 years.

A Legume

Black locust is a legume, capable of adding fertility to the land. The wood is heavy, hard, very durable. Its lasting quality is recognized by its popularity for fence posts.

Soil conservationists recommend planting it as a factor in gully control, and for the enrichment of soil in other badly eroded areas.

Locust reproduces freely from root suckers, stump sprouts, and seeds. Spring is the best time for planting but seedlings may be set out in the fall.

STOCK PONDS

(Continued from page 47)

water needs of livestock vary with the character of feed and the weather conditions, but average about 10 gallons a day for cattle and horses, and 1 to 1½ gallons a day for sheep and goats. A reservoir for temporary use to augment other sources of supply during dry seasons need not be so large as one for permanent use. If reservoirs are filled from streams which flow much of the year, or from washes where frequent flows occur, a basin of smaller capacity is required than when flow is limited to short periods. The importance of seepage and evaporation losses and methods of reducing them have already been discussed. Loss of water from both these causes must be allowed for by increased capacity of the reservoirs. Allowance should also be made for loss of capacity by silting.

Earthen dam built by Soil Conservation Service in Missouri in fall of 1934; depth, approximately 7½ feet; capacity, approximately, 14,000 gallons.

Table showing differences between evaporation during an average year and a drought year in the Great Plains

[Data from U. S. Bureau of Plant Industry]

Station	Evaporation, April–September, 15-year average, in inches	Evaporation, April–September, 1934, in inches	Difference
Havre, Mont	35.32	44.06	8.74
Moccasin, Mont	34.29	43.31	9.02
Dickinson, N. Dak	34.63	47.03	12.40
Mandan, N. Dak	34.18	40.75	6.57
Ardmore, S. Dak	37.64	49.62	11.98
Archer, Wyo	36.52	43.95	7.43
Sheridan, Wyo	34.42	40.38	5.96
N. Platte, Nebr	39.33	55.34	16.01
Garden City, Kans	54.67	70.53	15.86
Hays, Kans	46.01	66.35	20.34
Colby, Kans	41.77	57.45	15.68
Akron, Colo	43.73	52.62	8.89
Lawton, Okla	43.63	57.85	14.22
Dalhart, Tex	48.08	61.13	13.05
Big Spring, Tex	55.99	62.28	6.29
Tucumcari, N. Mex	54.52	67.22	12.70

THE SOIL BUILDER

(Continued from page 51)

land between the gully and the fence had grown up with sassafras, red oak, and hickory bushes, and there were some blackberry thickets in some places. The rest of the land was in cultivation and was streaked with a few little gullies but most of it was nearly flat and the soil was reddish yellow. The old man said it was an example of what sheet wash would do.

It finally got so the old man would wander over to that side of the field and look at the gully and the washed land more and more. One day he climbed over the fence and stomped up and down between the rows of stunted cotton and began talking to himself. I heard him mutter something about the foundations of civilization being undermined. I thought probably he was getting up one of his sermons.

Reclamation Begins

It was not long after this that the old man bought this adjacent 10 acres. One of the neighbors told me that he had given two prices for it. I have never seen anybody work so hard as the old man did that year. He had the bushes all cleared off the new land in no time. Then he started to work on the gully. Will told me he was going to quit. He said he wasn't going to kill himself for no dollar a day. We hauled rocks by the wagonload and built great walls of rock across the gully. Then the old man filled in behind with brush, blackberry-vine stems and little rocks. Behind the initial wall he laid heavy tow sacks. I had never seen him take so much care. Along by the fence he had a ditch dug to take care of the surplus water.

Right after the dams were completed a big rain came and the water tore holes in the dams in several places. But the old man was out early the next morning and put all the rocks back in place and strengthened the weak places.

He planted the poor part of the field in cowpeas, had us pick the peas when they were mature and then turned the vines under. In 3 years' time you wouldn't have known it was the same 10 acres. The gully was nearly filled up and we were plowing over it. All the rows of the forage crops were run on the contours of the slope and there was little or no wash even during big rains. The soil looked darker and every year the yields were larger than the preceding one.

The old man died in 1924. I went to the funeral service in a church in Fort Smith where once he had been the pastor. The minister told what a good man he was and how many souls he had saved. He didn't mention the soil he had saved.

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

ELEMENTS OF GEOGRAPHY. By Vernor C. Finch and Glenn T. Trewartha. New York and London. April 1936.

It is almost 2,000 years since a Roman man of letters, Marcus Tullius, known forever after as Cicero, referred in his De Natura Deorum to the age-long quest for the laws of life, the principles of existence, and the relation between the planet Earth and the phenomena of the elements: "The beauty of the world, the order of the celestial system, the revolution of the sun, of the moon, of all the stars, indicate sufficiently, at a very glance, that all these things are not accidental."

Since the day of Cicero, so much factual knowledge has accumulated concerning the earth's land regions, the gaseous envelope called atmosphere, and the depressed segments of the earth's crust, which are filled by the oceans and the great seas, that men safely explore the poles, climb the stratosphere, descend the deepest depths of the sea, and the authors of this book of 782 pages state in all humility that their work is merely "in the nature of an introductory handbook the contents of which should facilitate the observation and study of regional phenomena."

In its approach to the study of Earth's regions this new book presents an analysis of natural features or elements, more especially those having significant relationships to character of land utilization. Nature and distribution of material features existent in the present age are emphasized, rather than origins or processes of formation, although the latter are not neglected. As an illustration: stream origin and development does not receive the same extended treatment as do such stream features as delta plains, alluvial terraces, and stream erosion.

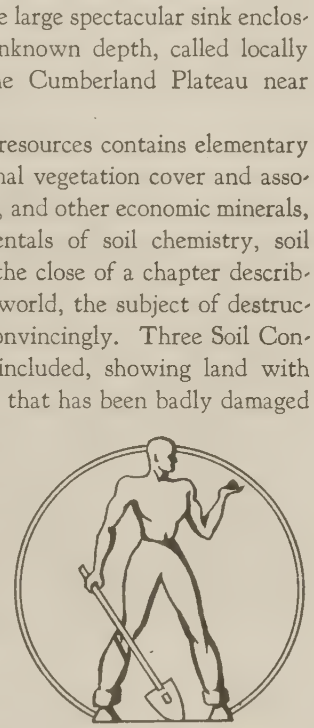
At the outset this text presents three chapters which are introductory in form and structure. Herein the field of geography is defined, earth motions and planetary relations are outlined, and a study of maps and their interpretation proffers the essential tool of the geographer.

The study of climate, the major element, is approached through a consideration of elements and processes of the atmosphere. Through a grouping of knowledge concerning sun energy and atmospheric temperatures, general features of temperature distribution over the earth's surface, winds and atmospheric pressure, the planetary system of winds, atmospheric moisture and precipitation, and storms and their associated weather types, the student is prepared for the subject of separate climatic types and their distribution. An interesting feature of the chapter on atmospheric pressure and winds is a discussion of a wind system as it might develop on a homogeneous nonrotating earth with maximum solar energy received at the Equator. A study of ocean drifts and currents from the viewpoint of climatic significance is also included in this chapter.

The general scheme or outline of climatic type subdivisions follows Köppen, with reference, for advanced study, to the world classification of climates emphasizing numerical values of temperature and rainfall for defining boundaries of climatic types, by Dr. Thornthwaite. Each climatic type—tropical rainy, dry humid, mesothermal, humid microthermal, polar—receive special treatment as to location and boundaries, precipitation, temperature, winds, daily weather, seasonal weather, and local variation.

The study of land forms is approached through a brief survey of the materials of which they are composed, the processes by which they originate, and the agents involved in their origins. Important earth elements and surface molding forces, tectonic and gradational, are treated with special emphasis on plains of stream gradation and glaciated plains, shore features of plains, plateaus, hill lands, and mountains. Of particular importance is the section of the book, consisting of approximately 100 pages, which treats of plains. Highly important, too, from the standpoint of the soil conservationist, is the comparative roughness of plains. This element of roughness is significant because indicative of various aspects of human utility of plains, such as the freedom of drainage, rapidity of soil erosion, or the ease of tillage. Of interest are the karst plains, variously distributed over the earth, surface features of which result from the solvent work of underground water. Region such as this are underlain by sediments which include layers of pure limestone. Instead of stream-eroded drainage patterns, karst plains have undulating, rolling, or sometimes rough surfaces in which numerous depressions without visible outlets are separated by low, irregular ridges or hillocks without definite pattern of arrangement. The depressions, generally called "sinks", are associated with underground drainage. Notable among the karst plains in the United States is the undulating to rough region in south central Kentucky, which is underlain by cavernous limestone. Considerable parts of this region are so dominated by solution features that sinks and their associated knolls and ridges are the principal relief features. Under primitive forest conditions many, if not most, of the sinks had free underdrainage. Since clearing, soil erosion has stripped clay from the adjacent slopes and deposited it in sinks until they are now ill-drained and contain at least temporary ponds. No mention is made in this text of the large spectacular sink enclosing a lake of deep blue water of unknown depth, called locally Montlake, which is located on the Cumberland Plateau near Chattanooga, Tenn.

The section of the book on earth resources contains elementary treatments of water resources, original vegetation cover and associated animal life, mineral fuels, ores, and other economic minerals, and, in outline form, the fundamentals of soil chemistry, soil physics, and soil classification. At the close of a chapter describing the principal soil groups of the world, the subject of destructive erosion is treated briefly but convincingly. Three Soil Conservation Service photographs are included, showing land with incipient gullying, a cultivated slope that has been badly damaged by gullying, and Mr. Bennett's own photographic masterpiece, originally published in Geographical Review, showing a field with soil completely destroyed for agricultural use by unchecked gullying.



The second part of this volume is, in its content, unique among American textbooks of geography. It deals with material culture, and

is a classification and outline study of the types of features resulting from human activities in the various regions of the world. It involves density and distribution of population; houses and settlements—rural villages of the Far East, the market town, the city; the distributional pattern of agricultural land—rice in the river floodplains of Ceylon and coconut groves on the interfluves; multiple cropping and interculture in Japan and Italy; livestock per square mile, per 100 acres of crop land—or pastoral nomadism on the Asiatic tundra; farm shapes and composition; manufactural features; the extractive industries—logging, mining, fishing, hunting; transportation and terminal equipment.

Part III deals with the earth's largest geographic subdivisions, here designated as realms, and is in the nature of a regional synthesis and summary of those features of the natural earth which previously were discussed individually and analytically. Emphasis is upon regional integration of the several natural elements. They are studied as interrelated component parts, areally associated. In this study of realms, emphasis is placed also upon an evaluation of the resource endowments or natural equipment of each realm for human use.

The five geographic realms (humid tropical, dry, humid mesothermal, humid microthermal, polar) are treated separately as to location on the earth's surface, climate and climatic influences upon human beings, vegetation resources, soil resources, landforms and drainage, and regional aspects. The subject of run-off and soil erosion is treated briefly in dry-realm association.

The appendix contains supplementary climatic data for selected stations; a selected list of United States topographic quadrangles; and an excellent chart of Earth's history as recorded in the rocks of North America. The book is rich in illustrations selected with the special purpose of centering attention upon significant features under discussion. The pocket plates accompanying the book have been prepared in blank, and are intended for student drawings and coloring as a manual aid to the appreciation of significant facts and associations in the distribution of earth's phenomena.

Reference lists are appended to those chapters, sections, or parts of the book that treat of distinct fields, and are intended to suggest some of the more recent of the authoritative general works in each field.

California barranca being straightened by C. C. C. workers. The old one overflowed during rainy season and caused heavy silting in nearby orchards.

PEDOLOGY. By Jacob S. Joffe. 1936. Introduction by the late Dr. Curtis F. Marbut.

In this book the American pedologist may have opportunity to familiarize himself with the history of the development of pedological science in Russia, which fact alone makes it an important contribution, for, as is set down in the introduction by the late Dr. Marbut, "It was Russian work which brought the study of soils out of chaos and confusion of the geologic, agronomic, chemical points of view and established it firmly as an independent science with criteria, point of view, method of approach, processes of development applicable to the soil alone and inapplicable to any other series of natural bodies." And it was Russian work which determined a definite relationship between the soil and the environment in which the soil is found, thus showing the soil to be related, on the plane of development, to biological bodies and not wholly physical.

At the outset Professor Joffe discusses pedology as a scientific discipline, coordinating it with, and at the same time separating it from, the other earth sciences—chemistry, geography, physics, geology, etc.; and from thence progresses to practical and cautious presentation of the subject of soil morphology. In this section of the book, wherein are given detailed directions for studying and sampling the soil, the author states that some of the morphological features, such as color, structure, and distribution of constituents in the profile, lend themselves to experimental verification in the laboratory.

Under the heading, Soil Genesis, Professor Joffe treats of weathering and soil formation; soil-formers, passive and active; and soil-forming processes. The summary of Schmuck's ideas on soil organic matter is given, and also Kurilov's table showing the relation of humus to mineral content of soil.

In an extensive treatment of the subject of soil systematics, soils of the world are grouped according to formation—desert, semidesert, and arid; chernozem; podzol type with subtypes and transition types in the podzol zone; tundra; laterites and lateritic type; intrazonal; bog and marsh; mountain soils. In the section treating of chernozem soils the author presents the views of various pedologists concerning the prairie soils which border the eastern edge of the meridianal belt of chernozem soils in the United States. In his discussion of soils of the prairie province, Professor Joffe has this to say, "Since characteristics point to the degradation process, one cannot help but place the prairie soils into the subdivision of the degraded chernozem" [this view is opposed by Dr. Marbut, and he expresses his reasons in the introduction of this book] "the inherent nature of which is a somewhat leached condition with all its accompanying effects, among which are the shifting of the lime zone deeper into the profile and to ultimate disappearance as the podzol process of soil formation predominates. Whether or not the prairie soils that show no lime zone will ever become more podzolic is a debatable question. A solution to the problem lies in establishing the balance between the outgo and the return of bases, in the alkaline earth in particular. A practical approach to the experimental solution of this problem has been suggested in connection with a discussion of the status of some podzolic soils in the great podzol zone. The lysimeter method of studying the leachings and an analysis of the incoming materials are the salient features of this approach." Glinka's tables showing composition and water extract of meadow land soil from Seja Bureja, Amour Region, are shown in connection with the study of bog and marsh soils.

In his final chapter Professor Joffe gives a brief history of soil studies in the United States, beginning with the inauguration of the Soil Survey in the early nineties, and including Dr. Marbut's scheme of classification by categories with a discussion of pedocals and pedalfers as "the one novel feature which brings the grouping of the soils of the United States by Marbut one step closer to a harmonious system."

The book has nearly 1,000 references, much tabulated data, adequate illustration, and both subject and author index.

U. S. GOVERNMENT PRINTING OFFICE: 1936

FORESTRY PUBLICATIONS USEFUL IN SOIL CONSERVATION

Compiled by Mrs. Etta G. Rogers, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue

Office of Information United States Department of Agriculture

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[1] Available to Soil Conservation Service field offices from the Service Library on a loan basis only.

HOW TO HOLD THE SOIL

SOIL CONSERVATION

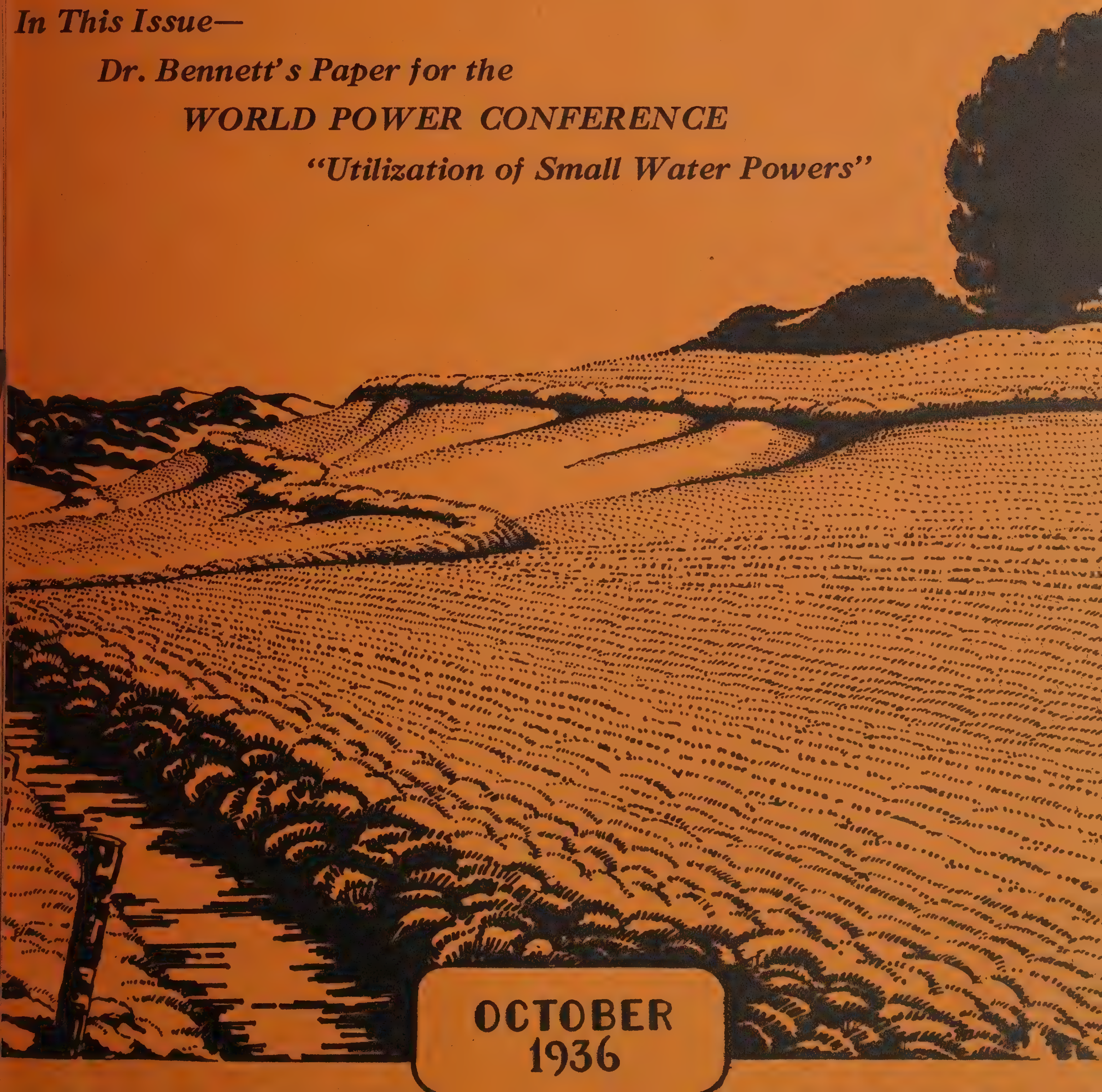
OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

In This Issue—

Dr. Bennett's Paper for the

WORLD POWER CONFERENCE

"Utilization of Small Water Powers"



OCTOBER
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WELLINGTON BRINK — EDITOR

SOIL CONSERVATION

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Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

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ANCHORING THE CLATSOP DUNES WITH VEGETATION

By E. M. Rowalt

Even after sand from eroded inland ranges and cropland areas of the Northwest is swept out to sea by the swift currents of the Columbia River, the Soil Conservation Service is not done with it. The sand rises—and the phrase is used here in its literal sense—to plague the Service again.

The sand rises in dunes. Much of the sand load of the Columbia, moved about by ocean currents and tides, eventually is swept on to beaches south of the mouth of the river. There the sand is picked up by the winds, which blow prevailingly in an inland direction, and is moved back east, overland. To stop the destructive advance of these sands, and to demonstrate measures of protection for other areas of the Pacific coast similarly affected, the Service established a project at Warrenton, Oreg., a year ago. The project personnel was given the job of lashing down the mobile dunes by vegetative means.

Back from the coast line, in the direction of advance of the surging dunes, lie valuable farm lands, a State road, a Government military reservation, and popular recreational centers. Were the dunes to move on un-

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checked, valuable private and public properties would become enveloped in sand within comparatively few years. Last winter the dunes moved eastward 150 yards along a 16-mile front.

The blame for this condition of accelerated erosion must, as usual, be shouldered by blundering man; but—and here the picture is a bit unusual—the original sin cannot be pushed off upon blame-burdened pioneer generations. It was not their misuse of the land that caused the trouble. To the contrary, the settlers of two generations ago were aware of the unstable nature of the sand below the thin mantle of the soil which covered the area, almost to the tide line, and for the community good they passed an ordinance immediately Clatsop County was incorporated, in the late 1860's, prohibiting the grazing of all land west of Neacoxie Creek, a narrow body of fresh water extending parallel to the coast. For almost 40 years the ordinance was respected; a few offenders, at first, were heavily fined.

Effect of Close-Grazing

But new people came into the region. The newcomers ignored the ordinance, subdivided the land, brought cattle, and grazed the rich grasses. Close-grazing soon killed out the grass, exposing the sands to the unbroken sweep of the winds. The sands piled into dunes which rolled eastward before the almost-constant pressure of prevailing easterly winds. The Neacoxie, half filled with sand, is now a series of ponds traversed by dunes. The dunes have encroached upon the parade grounds of the military reservation, and in parts of the area the county has given up its efforts to maintain open roads to the beach. Clatsop County people are worried, and they observe with growing interest the progress of the demonstration.

Paradoxically, the first step in stopping the advance of the dunes, according to the technique worked out by the Service, is to build a dune. This man-created "fore" dune is built parallel to the coast about 150 feet back from the tide line. Its purpose is to break the sweep of the ocean winds as they lash inland.

Building a "Fore" Dune

To build the dune, a double-line picket fence is driven into the sand in the position desired for the dune. The incoming sands pile over the fence. Each time the stakes are covered they are pulled half their length. This is repeated until the dune attains a height of 8 or 10 feet. The dune is then planted to sand-stilling and sand-catching grasses, such as Holland and American dune grasses. The vegetation collects more sand and the dune gradually rises to its ultimate height of 20 or 30 feet.

A second control step, which is carried on concurrently with the dune building, is the planting of dune grass species at 18-inch intervals over the blowing areas to the landward side of the "fore" dune. Later, as a third step, sod-forming and soil-building vegetation is established; and finally in those areas that will support such vegetation, trees and shrubs are planted for further protection.

The men on the project find that dune grasses are very exacting grasses. For example, T. A. Steele, project agronomist, finds that Holland grass survives only on barren, moving sand. When organic matter accumulates, or when the sands cease to move, Holland grass dies out. Even on comparatively still sand the plant loses the bright green coloring characteristic of the plant when growing on mobile sand.

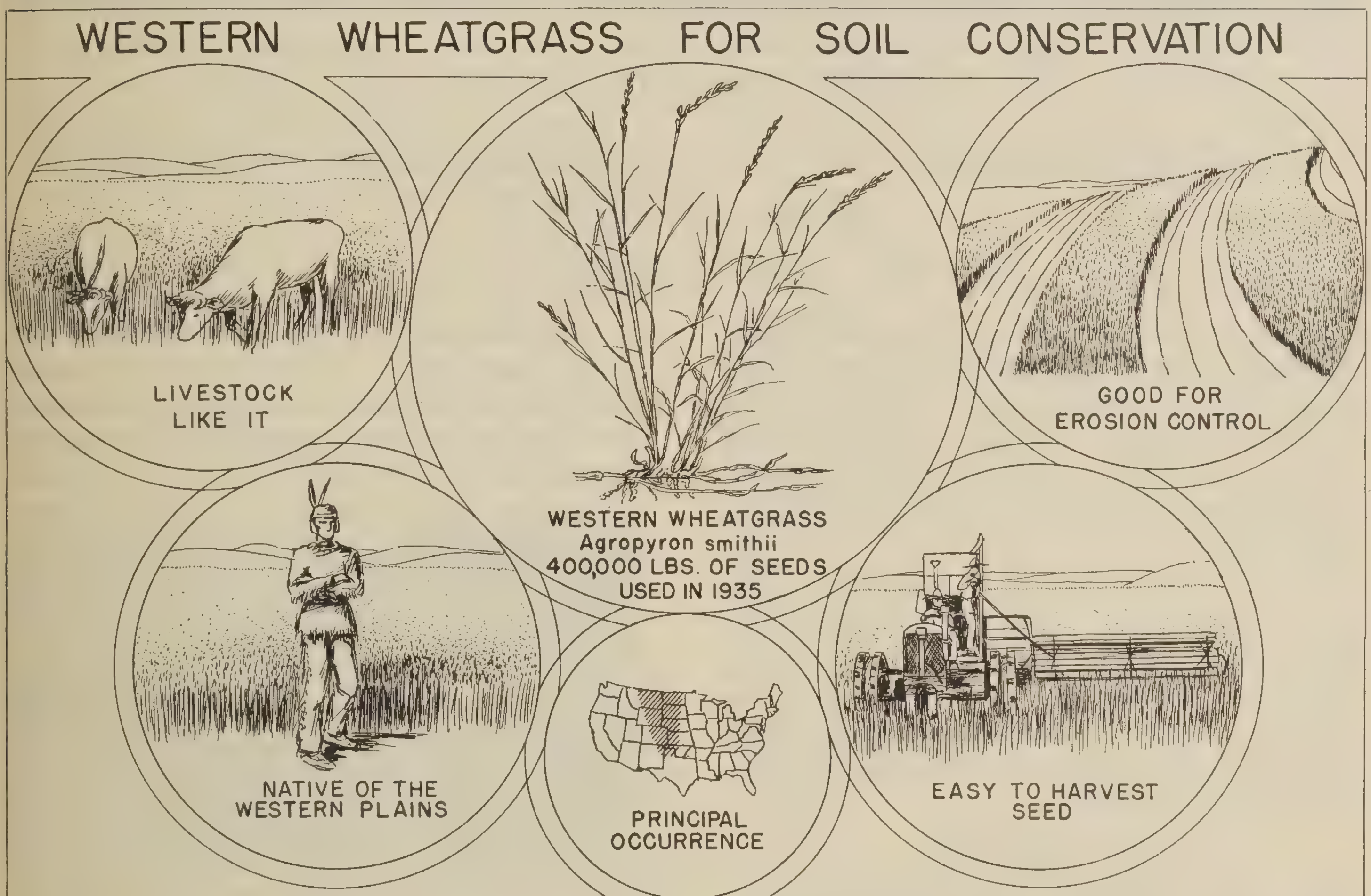
Planting dune grasses

Last fall C. C. C. boys planted an area 100 feet wide and 8,000 feet long adjacent to the high tide mark. Two weeks afterward a storm whipped up enough sand to cover the new planting 20 inches. Before the winter ended storms piled on 10 inches more. Yet when Steele made his counts in June he found that 95 percent of the Holland grass plants survived.

Various Plants Tried

Steele and M. V. Penwell, camp superintendent, are not prepared to say what the plant succession will be eventually. They are investigating various species of native and imported grasses, and will select the most promising of these to succeed the dune grasses.

What will become of the area once it is stabilized? Ultimately, portions of the area back from the water front may be returned to pasture use. But the area lying west of the Neacoxie Creek, where stabilization measures are concentrated, can never safely be used for grazing. Perhaps eventually it may become a center for grass-seed production. Clatsop County is a leading producer of bentgrass seed.



THE WEATHER HASN'T CHANGED

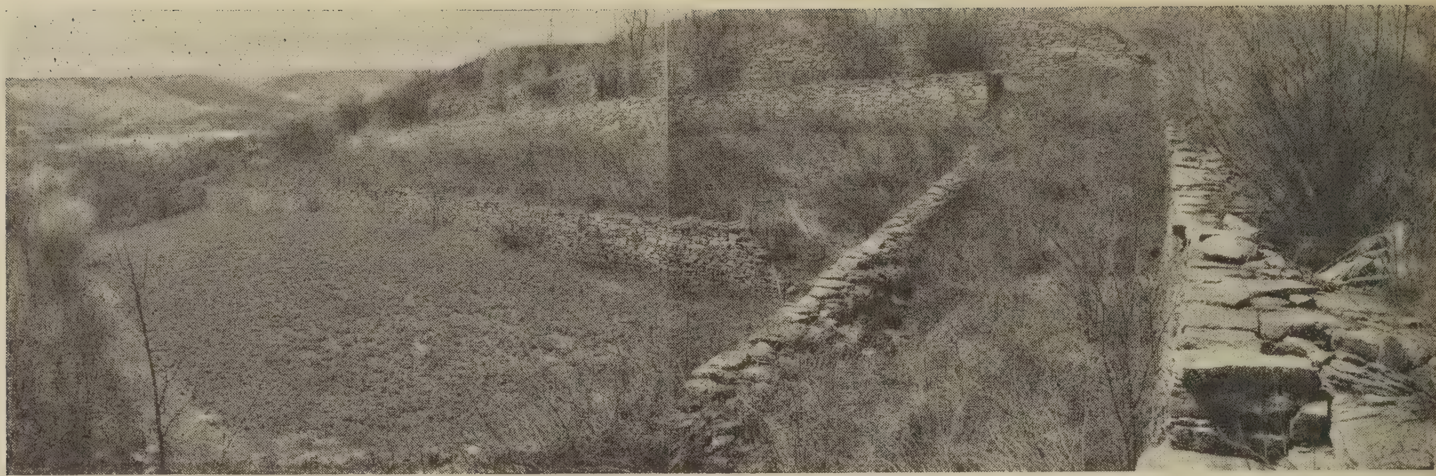
Rainfall on the Great Plains averages about 20 inches. Sometimes it falls gently, but more often it comes in brief torrents that rush off the land, carrying away vast quantities of precious soil and increasing the likelihood of floods. Cycles of dry years appear, as well as cycles of what might be called wet years. By and large, rainfall is the same that it has always been and wind velocity, also, has retained the pace of the centuries.

The significant difference now is that more land is exposed to damage by wind, sun, and rain than formerly. Low rainfall for 5 years, overgrazing for a number of seasons, and the tremendous expansion of the wheat acreage, are the principal factors which made it possible for wind and sun to do so much damage within recent years. The rapid increase in size of the affected areas, and the gradual exhaustion of the grass roots and soil-binding humus under conditions of cultivation are important factors that justify deep concern.

MOISTURE FOR THE FALLOW PERIOD

In many areas of the Great Plains the original vegetation has been almost totally destroyed by overgrazing and has been replaced with less palatable plants. On great stretches of range land less than 50 percent of ground cover exists today, and the late drought is responsible for still further damage. Large acreages of crop land, where the fallow system is used, have suffered from wind and water erosion. Due to rapid run-off of rain water, a relatively small percent of moisture is available for the building up of reserve for the fallow period. Thus the moisture content at seeding time is so low that seed may not even germinate.

Present known soil and water conservation methods, if properly applied, are adequate to hold the soil and insure crop production on the better lands of the Great Plains. It must be understood, however, that considerable land, widely distributed, is not suited to crop production and should be returned to the grass cover as soon as possible.



General view of steep slope on monastery farm. Structures at left continue around hill. Center bench has been cleared, preparatory to cultivation.

STONE TERRACES OF KENTUCKY DEFY EROSION FOR CENTURY

By F. E. Charles

Old stone terraces on high, steep slopes call to mind scenes of flourishing vineyards in the romantic Valley of the Rhine. In fancy one sees a system of patch-work farming high up on hillsides of the Old World, where peasants toil in the sun. The picture does not seem to fit twentieth-century America. It belongs to a bygone age.

So it might seem. Yet tucked away on an isolated Kentucky hill may be found such a sample of Old World farming. Within easy view of the skyscrapers of Cincinnati, yet seemingly far from civilization, lies a 100-acre hill farm, the steep slopes of which have been held in place by stone terraces for more than three-quarters of a century.

No Gullies Here

The farm is owned by the Benedictine Order of Monks and once was the site of a monastery. Today the farm is operated by a farmer who tills the place as other Kentucky farms are tilled although the monastery land offers striking contrast with other hill farms of the Ohio valley. Although the insidious fingers of erosion have gullied the slopes of other farms in the neighborhood, the terraced hillsides on the monastery farm remain unscarred.

Accompanying photographs suggest the nature of stone terraces on the monastery farm which perches on a ridge just west of Covington, Ky. The saga of the place says that some of the terraces were constructed before the Civil War, under the supervision of a Cincinnati lawyer. He employed 10 Frenchmen who, perhaps , had learned to build such structures in their native land. As they cleared the hillsides of loose stone, they piled the rock into parapets. Through the years these rock walls served to check erosion which, under normal cultivation, would have been serious, since the slopes vary from 35 to 50 percent.

Nearly Perfect Control

The terraces have been nearly 100 percent efficient in controlling erosion, A. H. Paschall, in charge of conservation surveys, region 3, reported after a survey. No visible signs of active erosion are apparent on the terraced area, whereas nearby unterraced land has been completely destroyed by sheet and gully erosion.

Terraces on the monastery farm reduce the steepness of slope to a point where tillage operations are comparatively easy. The reduction has a marked effect in retarding the rate of water run-off.

Holds Water

Depth of soil between terraces averages 5 feet, varying from 2 feet at the base of the uphill terrace to 8 or 10 feet at the downhill terrace. This thick mantle of soil provides an excellent reservoir for storage water. It contrasts strikingly with the badly eroded soil on nearby cultivated lands where

frequent gullies slash the slopes from top to bottom. Most of these gullies reach down to bed rock. The soil produces little or nothing. Sheet erosion between gullies has removed the soil to a depth of 24 to 30 inches.

An acre of the terraced land has about 10,000 tons of total soil mass; an acre of the unterraced land about 5,000 tons. The difference of 5,000 tons represents loss due to erosion, most of which is topsoil. From the standpoint of long-range economy, the original cost of building terraces on the monastery farm would, therefore, seem to be justified.

Construction

The method by which the terraces were constructed is not wholly clear. Apparently the walls were laid in trenches, excavated to bed rock. Then the soil between them was sloped by manpower. On a hillside paralleling United States Highway 25 are located the oldest terraces. The slope here varies from 50 percent at the top to 35 percent at the bottom. Between terrace walls the slope has been reduced to 13 to 30 percent.

On another slope, not visible from the much-traveled highway, benches between terraced walls have been leveled to between zero and 20 percent.

Alfalfa grown on bench without liming or fertilizing, the terraces having not only retained the soil but preserved the plant food.

These newer terraces are said to have been constructed during the Civil War, after the Order of Benedictine Monks obtained possession of the land. The monastery once employed 20 workmen in its vineyards and, not many years since, there were 35 acres of grapes on the place. The monastery was closed in 1919.

Well Preserved

The stone terraces are in a good state of repair, with the exception of an occasional flaw caused by hunters tearing them apart in search of rabbits. The

Effectiveness of the stone terraces in preventing erosion emphasized in this view of a rain-drenched, sun-bleached area not more than 50 yards from terraced area, on opposite slope. Once a vineyard. So severely eroded that 24 to 30 inches of topsoil have been removed between gullies, while bottoms of gullies now reach to bedrock. At left may be glimpsed a fringe of black locust grove which is rapidly helping to retrieve the area.

present operator of the farm has had considerable difficulty in this respect and only a year ago succeeded in having the land posted as a game preserve. The rock terraces are from 3 or 4 feet to 10 feet in height above ground. Wall thickness varies from 2 to 6 feet. Benches between the terraces are 75 to 100 feet in width. Steps at convenient locations lead visitor or husbandman from one level to another.

Modern soil conservation engineers might well contemplate the effectiveness of the riprap terrace outlets. Water catapults harmlessly from one bench to another because the outlets are paved with stone. There are no signs of erosion where water has run over these outlets, although it is obvious that vegetative cover keeps the amount of run-off water at a minimum. There is evidence that the natural waterways on the slopes have been paved with rubble from top to bottom.

Alfalfa Grew Well

The oldest of the terraced benches are not in cultivation today and are grown to weeds and forest. On the newer terraces part of the old vineyards have been cleared out to permit field cultivation. Last year one of the benches was planted to alfalfa and, although the weather was most unfavorable, a good stand was obtained. Another bench has been cleared, ready for cultivation.

Agronomists and foresters find points of interest on this monastery farm. Grass, trees, and shrubs, including honeysuckle, have come into the benches since they were abandoned nearly two decades ago. Black locusts are creeping in rapidly and there is a

(*Continued on p. 83*)

By
Charles
B.
Maits,
Jr.

There is a little gray-haired old lady living in Lancaster County, Pa., who can tell you something about soil erosion, and what it can do during the course of a lifetime. Her home is on the west branch of the Octoraro Creek near King's Bridge. Nearby stands King's Mill—an old-time grist mill, built more than a century ago, and in practically continuous operation, serving Lancaster County farmers till just a few years ago. The old log-and-masonry dam which spans the little creek, and which used to check the rushing waters in the rainy seasons, is a familiar landmark to all the residents in the neighborhood. They call the old structure King's Dam.

The Dam Went Out

During the summer of 1934, heavy rains washed out old King's Dam and incidentally gave an interesting, if somewhat costly, object lesson in soil erosion.

On viewing the damage, engineers of the Lancaster County project of the Soil Conservation Service discovered that the water pouring through the break in the dam, had gouged a deep V-shaped channel into a deposit of silt 11 feet deep—piled up to the very brink of the old spillway. Examination of this cut disclosed the fact that the richest soil lay at the bottom, while that towards the top was poorer and more sandy. Such a condition is a sad reminder of the fact that even the rains in Lancaster County can no longer find quite so rich a soil to wash as was formerly the case.

Calculations by the Soil Conservation Service showed that this one small dam had backed up approximately 27,000 tons of rich top soil, not to mention the considerable quantity of silt which undoubtedly had been washed over the top of the dam, and carried through the mill-race to flow over the old wooden mill-wheel. From the cut alone, some 7,250 tons of soil were flushed out when the dam gave way. The total watershed area contributing to this accumulation is about 1,200 acres, of which approximately 75 percent is cultivated farm land.

But this is only part of the story. The gray-haired old lady who lives nearby says that, many times before, the waters of the Octoraro have broken down old King's Dam. Each time the unloosed flood has torn the embarked silt from the break of the dam, to deposit it somewhere else further down the stream.

Continuous Silting

According to the little old lady, it generally requires from 1 to 2 years after the dam has been repaired, before the hard-working Octoraro can again accumulate enough silt to fill up the channel caused by the break. Thus, the deposits washed from the cut indicate a loss of about 5 tons of soil per cultivated acre per year, from the farms located above the dam.

From this it is easily calculated that during the lifetime of this little lady—she is over 80 now—approximately 400 tons per acre, or about one-half of the total topsoil, has been lost from the cultivated land within the boundaries of this one small watershed.

The old millwheel, if it could speak, might tell many an interesting tale of the "good old days." And the little old lady, when she was a little girl, knew these same "good old days." Both of them watched and listened, year after year, as thrifty, hard-working farmers drove their Conestoga wagons, piled high with golden grain, to the old mill. Both of them heard those farmers discuss the problems of their times while they waited for their grain to be ground between the ponderous old millstones. And perhaps the old millwheel (if it could think) may have felt a little sad as it turned on and on, grinding the grain, because it was driven by the water that was robbing those farmers of the very soil in which that grain had flourished.

Other Streams as Destructive

Much water has flowed over many dams, in all sections of the United States, since the day King's Mill was built, and there are many streams that have carried heavier burdens of silt than the Octoraro—chuckling and boasting as they rushed over other old millwheels

(*Continued on p. 71*)

A GRAPHIC METHOD OF SHOWING THE RELATIONSHIPS OF EROSION, SLOPE, AND COVER

By H. Howe Morse [1]

Pastured woods showed a greater amount of erosion than pasture in a recent study of planimeter data of the Salt Creek project, Zanesville, Ohio. Such a conclusion appeared to be exactly contradictory to general field observations. Further examination, however, showed that most of the woods occurred on steeper land than the pastures and that the woods were more effective than pastures in controlling erosion if the erosion was compared on similar slopes. Therefore, it became necessary to take into consideration the slope of the land when comparing the cover and erosion.

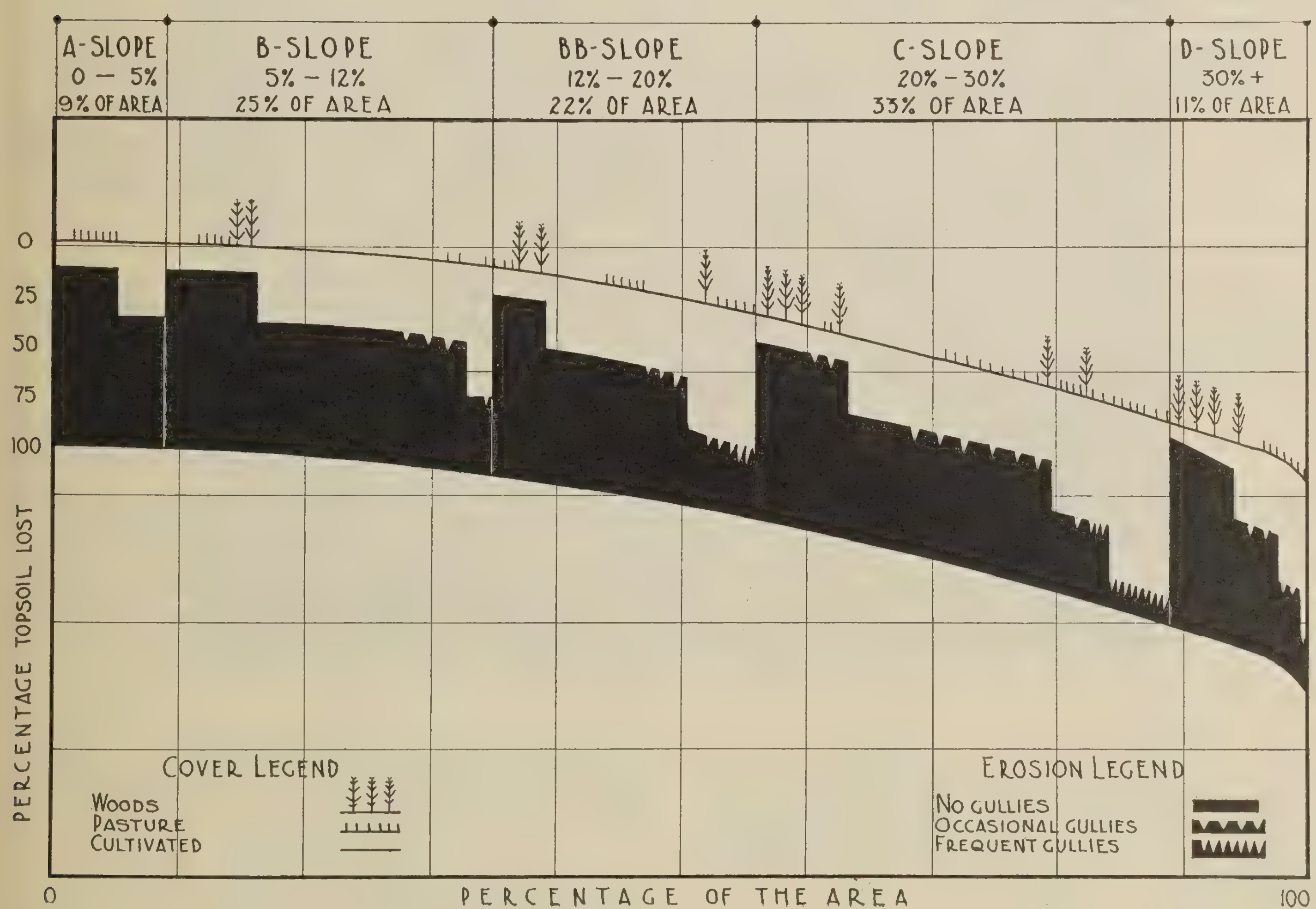
The presentation of three or four factors in a table or graph, however, is fraught with the danger that the relationships may be obscured by voluminous tables or, if in a graph, by a large amount of detail. Nature itself suggested a simple method of presenting these relationships graphically. An illustration of the method is given in the accompanying graph.

The original surface of the ground was graphed showing the actual slope of the land, using the percentage of the area as the abscissa. Below this line another was drawn showing the amount of sheet erosion which has taken place on each slope class, proper symbols being used to indicate the instances where gullying was combined with sheet erosion. Then the cover was indicated on the original surface to depict the relationship of cover and slope to the erosion which has occurred. The finished graph shows the percentage of the land in each slope class and the amount of erosion on the different slopes. It also gives the distribution of the cover on the different slopes and their relation to the erosion on those slopes.

[1] Soil scientist, region 3, Soil Conservation Service.

PLATE No 1

METHOD OF SHOWING COVER, SLOPE AND EROSION



LONG EXPERIENCE WITH STRIP CROPPING CITED BY FARMERS

By Guy C. Fuller [1]

During the past summer I personally visited a number of farmers in southwestern Pennsylvania and southeastern Ohio who have for many years made strip cropping an integral part of their operations.

For convenience in assembling the information I desired, I carried with me a questionaire covering such points as when strip cropping was begun, reasons for adopting the practice, and the results obtained.

Fifteen farmers were contacted. Of these, 14 are owners and operators and 1 a tenant.

The average farm covers 112.8 acres, the largest 193, and the smallest 39. The average number of acres of crop land is 45.8, pasture land 33.3, and woodland 20. The 45.8 acres of crop land were at the time of the survey about equally divided between corn, oats, wheat, and grass—that being the common rotation. These 15 farmers have been practicing strip cropping for a long period of years—10 years being the shortest period and 28 years the longest.

Examination of the data reveals the following reasons for starting strip cropping:

4—"To save the soil."
4—"To prevent erosion."
1—"To keep the soil at home."
2—"Because dad farmed that way."
1—"To prevent gullying."
1—"To get longer fields and to prevent washing."
1—"After ruining one field I had to start strip cropping."
1—"My father and grandfather farmed by using strips."

Method of Laying Out Strips

The following summary indicates how farmers went about laying out their strips:

12 of the 15 have their strips on the contour.
9 farmers guessed at the contour.
1 farmer used a tapeline.
4 farmers stepped off the strips.
1 farmer stepped off the strips and set stakes to guide him while driving around the hill.

Width of Strips

Strips range from 50 feet to 450 feet in width, the average falling between 150 and 200 feet.

Determination of Strip Width

Nine farmers varied the width of strips according to the percent of slope. Six farmers determined the width of strips by the number of crops they wished to place upon the slope.

Deviation from the Contour

A few of these farms which are in project areas have had the strips checked with an instrument to determine how far they deviated from the exact contour. Of the strips that were checked, none of them was over 3 percent in error. In about 50 percent of the cases slight changes were made in the strips after the first year of cropping. The changes were made in the countor lines where there was evidence of erosion during the first year of strip cropping.

[1] Associate agronomist, Soil Conservation Service.

Crop Rotation

With two exceptions, corn, oats, wheat, and grass constituted the crop rotation. Two individuals omitted wheat because they felt it was removing too much from the soil. This may or may not have shortened their rotation, for they plowed the meadow strip giving the lowest yield and providing the least protection against erosion.

Cropping Plan

The same cropping plan is used by all 15 farmers; that is, they never plow two strips side by side on the slope. Occasionally due to failure in obtaining a grass stand, this cannot be avoided. In that event, a close-growing crop such as oats or wheat is placed on the slope and reseeded with the grass mixture. These farmers favor a meadow or grass strip below a plowed strip.

Crop Yields

As to crop production—

7 farmers reported better yields.
2 believed that on an average they were gaining a little each year.
3 reported maintaining yields.
1 enthusiastically reported one-third increase.
1 was thoroughly sold on the practice, emphatically stating that his yields were six to eight times greater.

The outstanding farmer contacted reported his yields as being increased from parctically zero to excellent, which, according to his figures would mean a yield increase of four to five times. This was the only farmer giving figures on yields, to support his statement.

Use of Cover Crops

One farmer reported the occasional use of rye or wheat. It has not been a common practice. Three intend to take up this practice. The remaining 11 have never used winter or summer cover crops.

Fertilizer—Kinds and Amounts

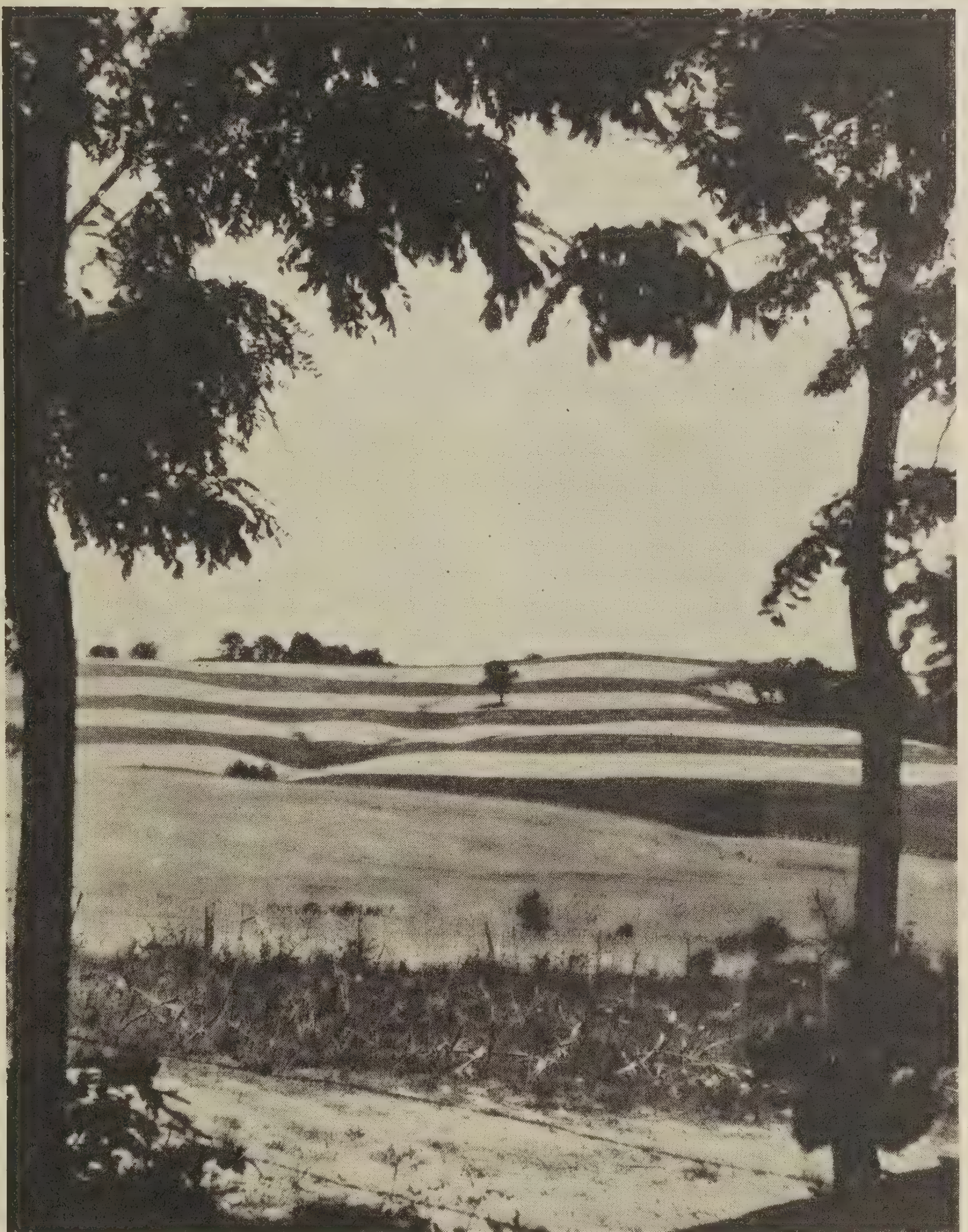
The average amount of fertilizer, mainly superphosphate, supplied on all farms, is 190 pounds per acre. In a few instances complete fertilizer has been used for the past 3 or 4 years. The largest quantity reported was 250 pounds per acre, the least 100 pounds per acre. Each farmer realizes the necessity of applying commercial fertilizer, but in many instances, because of low market prices the normal application has been reduced within the past few years. Commercial fertilizers are applied annually with each crop. These farmers recognize the value of manure and attempt to feed as much roughage as possible, consequently the bulk of the grain straw and corn ensilage is returned to the soil in the form of manure.

Lime

The average amount of lime applied per farm is 1 ton of hydrated lime per acre, this being applied in the oats or wheat when the land is being seeded to grass.

Crop Residue

In all cases crop residues are removed from the fields.



Strip cropping in Ohio.

Terraces

In no case has terracing been done, and each farmer reported that terraces would not be beneficial in his strip-cropping program.

Pasture Management

Eight of the fifteen farmers are practicing alternate grazing, the other seven continuous grazing.

Pasture Treatment

One of the fifteen farmers reported pasture treatment, and that was in the form of manure only.

Supplemental Pastures

One farmer has been growing soybeans for several years. Another has been growing soybeans and Sudan grass for supplemental feed, 1 to 3 acres per year.

Number of Silos

Ten of the fifteen farmers have silos and use corn as silage. In two instances, the farmers husked part of their corn and used this as concentrate in ground form for dairy cows.

Kind and Number of Livestock

Including cows, beef animals, and heifers, there is an average of 22.2 head per farm, the majority being milk cows. One farmer has 75 sheep, another 25 sheep. There is an average of 3.7 head of horses per farm, and four farmers own tractors.

Treatment and Use of Timber Land

Six of the fifteen farmers graze their woodland, and all of them cut their own posts and obtain some firewood. Two farmers have applied grass seed to their timber land after some thinning.

Protection of Natural Waterways

In all cases a good permanent sod is maintained in waterways. This point was stressed by each farmer, and it was emphasized that the sod strip should be kept "plenty wide."

Soil Type

As they are within the watershed area, five of the farms visited have been mapped by members of the Soil Conservation Service. The dominant soil on these five farms is Gilpin gravelly silt loam. Major soil types on other farms visited are Westmoreland silty clay loam and Belmont silty clay loam. The average percent of slope is BB, the majority falling between 15 and 25 percent. There are some 30-percent slopes and a few 5-percent, with an average of 3 erosion, the majority of this falling below 50 percent on the five mapped farms.

Types of Erosion

Sheet and gully erosion have been most serious. Sheet erosion was most serious where the strips were too wide at the time of initiating strip cropping, but this has been corrected by narrowing the strips. On many farms gullies were prevalent and serious at one time, but through proper treatment and use of vegetation every one has been filled or stabilized.

Strips and Conservation

Two farmers reported strip cropping as being "inconvenient." Eleven reported that it was "more convenient." One said it was the "only way to farm." One reported that he could plow 50 percent more per day. Every farmer agreed that it was more economical.

Advantages

All farmers reported that it was to their advantage to practice strip cropping. Experience had taught them that it was the only possible way to farm the hills, and after their fields were stripped and they had become adjusted to the practice, nothing would turn them away from strip cropping.

Disadvantages

Two farmers reported grazing difficulties; three stated that it was inconvenient to cross the strips in passing from one strip to another, and one farmer reported a great disadvantage when the strips were very short.

The following comments are of considerable interest and are presented here in the way in which they were given to me direct from the owner:

F. M. Giffin, a noncooperator, purchased a 54-acre farm in southeastern Ohio in 1907 and shortly after increased his acreage to 90. In 1908 he observed that grass prevented erosion and caught the silt carried from plowed fields above. He started strip cropping. His strips range from 4 to 8 rods in width, and are placed approximately on the contour, the width of the strips varying according to the slope. He guessed at the contour lines when dividing the fields into strips.

After the first crop year, he made very slight corrections in the strips, placing them more nearly on the exact contour. The lines never were checked with an instrument, but were varied up or down the slope depending upon the amount of erosion occurring at various points.

A 4-acre field adjoining his barn lot, with an average slope of 25 percent, contained 4 deep gullies. For 3 years he did not grow enough on his farm to feed his livestock, which consisted of 12 cows and a team. He and his boys plowed these gullies in, up and down the slope, until he was able to cross them. Then the field was plowed around the hill, crossing the gullies. In 1908 there was practically no vegetation of any kind on the field.

Four bushels of grass seed was applied to this 4 acres, with rye as a nurse crop; but Giffin did not get enough grass to cover completely 1 square rod. The field was plowed again in the fall of 1909, and seeded to rye, which was harvested in the spring of 1910. Two and a quarter bushels of grass was seeded in the second rye crop, and a fair stand was obtained after adding a half ton of hydrated lime, 250 pounds of superphosphate, and a small amount of manure per acre.

In 1912 the field was plowed and put in corn, then oats, and seeded back to grass, which consisted of alsike, red clover, and timothy. The field was not plowed as long as this sod provided a good cover and yielded some forage—this covering a 3- or 4-year period. The field was thereafter included in his regular rotation of corn, oats, and grass.

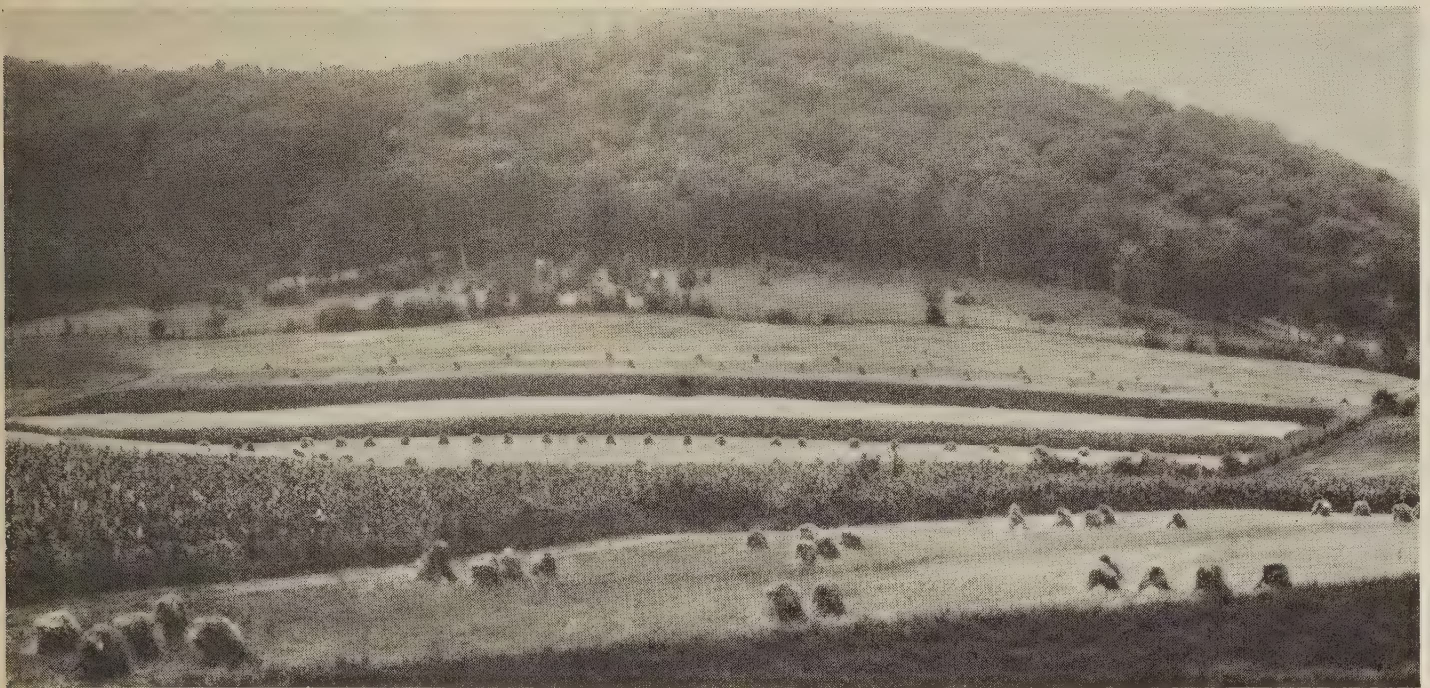
In 1918 Mr. Giffin started using alfalfa and has since been using it in the following mixture: 15 pounds of alfalfa, 12 pounds of timothy, and 8 pounds of red clover. The second cutting of alfalfa on this field at the present time ranges from 18 to 24 inches in height and is an excellent stand. When again this field is plowed Mr. Giffin expects to divide it into two strips.

Grass Mixture Controls Erosion

The crop rotation followed by Mr. Giffin consists of corn, oats, and the grass and legume mixture. He follows no definite order of rotation, but plows the meadow strip producing the lowest yield for corn. Mr. Giffin states that alfalfa alone does not prevent erosion, but by using the grass mixture greater yields are obtained, and erosion is held to a minimum.

When Mr. Giffin first grew oats on his strips, yields of 15 to 20 bushels per acre were obtained; in 1935 he harvested 64 bushels per acre from the same strips. In 1932 he failed to obtain a stand of grass on one strip, and it was put into wheat and reseeded. A yield of 42 bushels per acre of wheat was harvested.

At the present time, 37 purebred Jersey cows in addition to 1 imported purebred bull, 4 horses, a tractor, 2 trucks and a new



Strip cropping in Wisconsin.

family automobile may be found on Mr. Giffin's farm, which, undoubtedly, is an indication of what he has been able to do on those steep slopes and a comparatively small acreage

Some 30 of this farmer's neighbors have taken up the practice of strip cropping during the past 10 years, because they observed the higher yields obtained on his farm.

The Ohio State University called upon Mr. Giffin to give a talk for the benefit of other farmers in the State. He had pictures of his farm, showing the strips, and he gave an accurate narrative discussion of his practices.

J. C. Boyle, 7 miles southeast of Washington, Pa., remarked that during a 4-year period one of his neighbors abandoned one field because of erosion.

An Example in Point

J. D. Martz, in the vicinity of Vandergrift, Pa., relates the following story about a 30-acre field across the fence from where he is practicing strip cropping, the slope and soil type being approximately the same.

In 1898, Mr. Martz helped his neighbor thresh oats from this field, with an approximate yield of 37 bushels per acre. In 1924 they put up 25 tons of hay. After that the farm changed hands, and the purchaser plowed the entire 30 acres as one field. "Today", Mr. Martz remarked, "it would be impossible to ride a horse over that field." Gullies have been deepened from 2 to 3 feet during the past year. Across the fence, in Mr. Martz's own field, satisfactory crops are obtained and there are no gullies.

Narrowed His Strips

Fred Weiss, a cooperator in the vicinity of Indiana, Pa., made this statement: "I would have had a very good farm if my strips had been much narrower at the time they were laid out. Although I have no bad gullies, considerable sheet erosion occurred because the strips were too wide at the outset. I have, therefore, narrowed them down considerably."

H. H. Wetzel is so thoroughly sold on strip cropping that he would carry on this practice if his land were level.

Father Established Practice

Taylor Pepper, 1 mile north of Centerville, Pa., has never farmed without using strips, because it was the way his father and grandfather farmed, and when he bought his present place he stripped his fields the same as they had stripped theirs. Mr. Pepper has not only used strip cropping but has made a practice of diverting water from the low places on to the higher areas by using ditches, small dams, etc. He never allows a gully to get started.

Conclusion

Although accurate measurement was not made on all farms, it is believed that the average slope of all cultivated fields would fall between 15 and 25 percent. Every farmer visited has been able to control gullies by the use of vegetation and diversion of water. Although erosion has occurred on most farms, it will fall below 50 percent, as is indicated by the crop history.

Sheet erosion has been responsible for most soil losses because the original strips were too wide. The common grass-mixture used by these farmers consists of alfalfa, timothy, and red clover. Two farmers are of the opinion that alfalfa alone does not prevent erosion, and for this reason, and because it gives them greater yield of forage, they are using the mixture.

AN OLD-TIME MILL

(Continued from p. 66)

with their booty of priceless topsoil, stolen from countless thousands of farms throughout the land.

Is it any wonder that serious-thinking farmers, the country over, scratch their heads as they stand on their eroding land and wonder why crops are not quite so good as in their boyhood? To their fathers the soil was something solid and dependable. No depression or disaster could steal it away; no laws of man could alter its trustworthiness. Now their sons wonder, and are not so sure.

They could learn the story from a little gray-haired old lady who has lived beside the Octoraro for a long, long time.

The Inspirin

Golden

by

ERIC WALTHER

Increasing attention is being given to the task of reclaiming waste lands, either for agriculture or in the interest of scenic and aesthetic appeal. An example of such an effort, outstandingly successful by common consent, is the case of Golden Gate Park, San Francisco.

Barren Sand

In the days of '49, during the gold fever and for some time after, San Francisco was little more than a place of disembarkation. Its transient residents were too

busy to dream of a glorious destiny for this collection of shack
water's edge. The entire westerly part of the city and county wa
of sand dunes, shifting farther eastward with every breeze from
So dreary a spectacle was this desolate area that an official sur
"uninhabitable by man." In spite of this, a few enterprising in
on the more desirable locations in the western portion of the cit
or by proxy in the form of hired, armed guards. By the time t
came to the fore, little was left of these former "Pueblo lands."
long battle by a few public-spirited citizens, a compromise was
1,000 acres were returned to their rightful owner, the city, to bec
Many were the scoffers who doubted whether there would ever b
for the taxpayers' money sunk into this desert of sand dunes. Si
Golden Gate Park has become world famous. Today it ranks a
of the country—a monument to the civic spirit of San Francisco's
invincible faith of its veteran superintendent, John McLaren,
year of service.

Making Over the Desert

The transformation of this desert into a garden, the long years
and experience, yield many useful lessons to the soil conservationi

The first step essential toward reclaiming this area was to pre
ment of the sand dunes. Some preliminary attempts made use
seeds, sown during the rainy season, but success was only part
famous beach grass, *Ammophila arenaria*, was imported from Fran
of one of the Vilmorins, was any real progress made. It is not to
without this grass there would be no Golden Gate Park today.
is its ability to survive being covered, seconded by the binding
tough roots. Usually planted from divisions in the winter or ear
to live through a 6-months' rainless summer with only such moist
from the local fogs.

Only now was it possible to consider planting anything else
plants tested only a few proved able to live in the almost pure
not only of plant food but as dry as any desert for nearly half th
ing among the survivors were two Australians, *Leptospermu*
Acacia longifolia. Both thrived under the inhospitable condition
shelter for more decorative, taller trees. Of the latter the most

Pages 72–73

Story of

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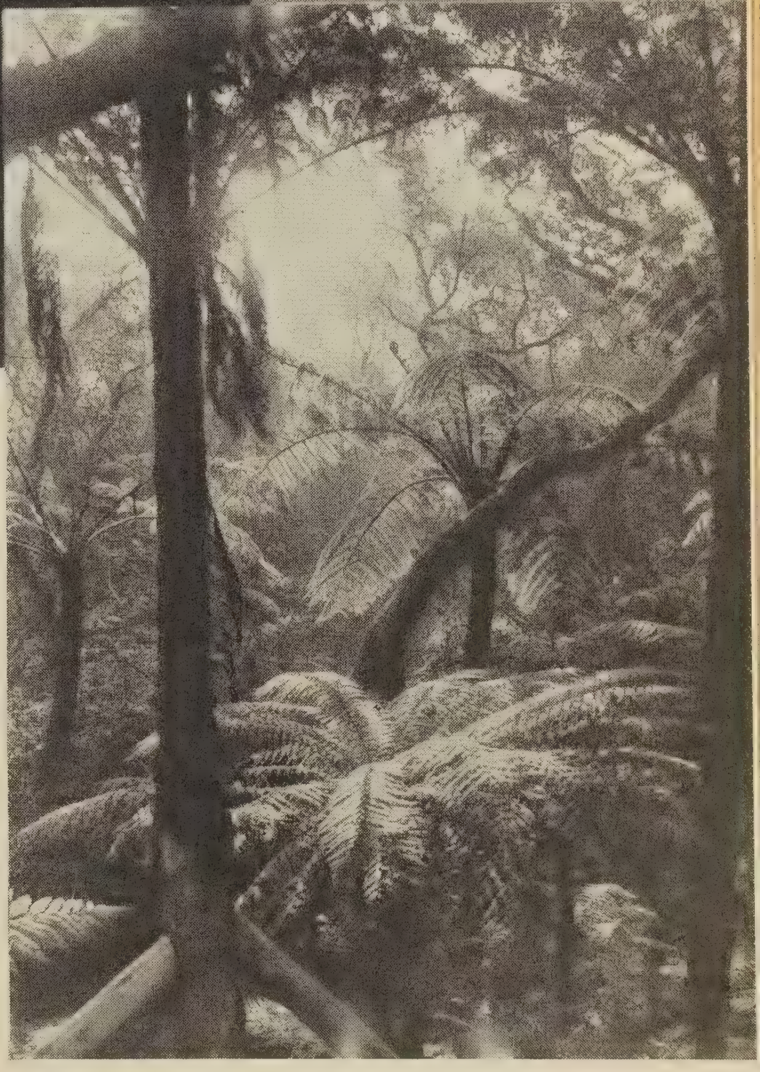
out to be two Californians, the Monterey pine and the Monterey cypress, supplemented by *Eucalyptus globulus*, the blue gum from Australia.

Water Problem Solved

With these as a framework on the foundation of pure sand, was painted the finished picture of our park, into the making of which went much labor and material even more prosaic. One of the important factors contributing to the park's success in earlier days was the street sweepings, brought here from all over the city. More recently a sewage-disposal plant has been installed in the park, not only adding to the water supply, but also producing valuable fertilizer. The water problem, always an acute one, was solved by the discovery of an apparently ample supply in the park itself. A large steam pumping plant, supplemented by two windmills near the ocean, yields a daily total of nearly 2,500,000 gallons of water.

(*Continued on p. 82*)



Pictures by the author. At the upper left we see silhouetted against the sky the famous beachgrass, Ammophila arenaria. *Below it is a view in the Japanese garden, as it is in cherry-blossom time. Above, to the right, is a flowering spray of* Leptospermum laevigatum; *and nudging it closely are flowers and foliage of the blue gum,* Eucalyptus globulus. *Also shown, is a refreshing glimpse of the tropical jungle of tree ferns.*

UTILIZATION OF SMALL WATER POWERS[1]

By H. H. Bennett[2]

The reawakening of interest in little waters and small water powers is a significant example of the profound transformation of the traditional American attitude toward the conservation and use of natural resources which is visibly in process throughout the Nation today. We are beginning soberly to realize that we have been a prodigal people and that the magnificent natural heritage with which we began our career as a Nation is not inexhaustible. In a new sense, we are becoming land and water conscious, forced by tragic experience of floods, erosion, dust storms, and drought to recognize the threat to the permanence of the economic foundations of our civilization which our traditionally individualistic exploitation of land and water resources has brought upon us. Not isolated technicians alone, but an increasingly substantial number of those who determine effective public opinion, are envisaging conservation in terms of the total resources of whole drainage basins, and of the interdependence of those resources and their users. The revival of interest in the conservation of little waters and the utilization of small water powers is significant principally as evidence in confirmation of the reach and penetration of the visible process of psychological readaptation which as a people we are making as a felt condition of national survival.

The story of our use of little waters and small water powers presents a typical cycle. The colonial history of America is vitally interwoven with the water wheel, with small power installations on great streams and small for the localized service of individual households, individual mills and factories, individual communities. The pioneering and dominant position which for generations New England held in the development of the factory system was due to the rare combination of ingenious settlers mechanically inclined with a glaciated terrain abounding in lakes, ponds, and streams of dependable flow and regulated by rock-bound channels. But New England was only a special case of what happened along both slopes of the entire Appalachian Mountain system. In the minds of the rugged pioneers, facing a boundless undeveloped continent, the streams, like their forest cover and their bordering soils, seemed inexhaustible and permanent as the hills.

Then came coal, the steam engine, the concentration of vast populations in commercial and manufacturing centers, a steady decline in the number of small water-power installations. For millions of Americans the very visual imagery associated with water changed from brooks and rills and wooded hills to pipes and taps and valves. What happened to the headwater ponds and marshes and lakes, the forest cover, the small tributary streams, did not disturb their minds so long as valves and taps flowed. Engineers appear to have shared with the urbanized layman this narrow and short-sighted preoccupation with impounded streams as water supply. According to the Water Planning Committee of the National Resources Board, "notwithstanding the patent desirability of comprehensive stream regulation in most of the North Atlantic drainage areas, the Hudson River Basin and a few minor basins are the only ones having either the plans or the administrative machinery requisite to achieving such regulation." Of the Delaware River, to cite a specific instance, this committee reports that regulation of the main stem is completely lacking with the result that not only power sites of great importance remain undeveloped, but even potential water supplies for New York, Philadelphia, and other metropolitan areas are not utilized. Water famines have threatened metropolitan areas even in years when vast damage has been wrought by floods and for the same reason. Such grim realities are compelling attention, such as that evidenced by the work of the Water Planning Committee, to the need for comprehensive stream regulation and the maximum conservation and use of all the resources upon which socially effective regulation depends.

The cycle to which the steam engine so largely contributed through the concentration of population in manufacturing centers, the steam locomotive helped to induce through the dispersion of the agricultural population over the western prairies and plains. In the minds of the land-hungry homesteaders, the water table into which they sank their wells seemed as eternal as had the hills and surface streams of the East. Established in proud isolation and proceeding each man to himself, they took little account of the relation to the water table of the distant headwater marshes and lakes, of the grassy ground cover, or of the innumerable small streams that regulated the run-off of melting ice and snow. According to the report of the Mississippi Valley Committee, 95 percent of the people in the Mississippi River Basin, outside of the larger cities, depend upon subsurface water for domestic and stock watering purposes. Due in large measure to mistaken agricultural practices and to the absence of any comprehensive public control of the total water resources, the water table, in vast stretches of the upper basin, has fallen at a dangerous rate, in some instances by as much as 30 feet; ponds and springs have dried up; marshes which functioned as indispensible natural reservoirs have been destroyed, sometimes through unwise drainage; the level of important headwater lakes has been seriously lowered. Duststorms and unprecedented drought over wide areas have made the people, both those directly affected and throughout the entire Nation, acutely aware of the relation of total water resources to agriculture, of types of agriculture to water supply, and of the need of dealing with the combined problem of soil and water conservation as a whole through the planned rehabilitation and control of entire river systems. Such plans have only recently been put into initial execution in the basins of the Columbia, the Missouri, and Mississippi, and most comprehensively in the Tennessee Valley. Obviously the cost of such colossal undertakings is enormous. Fortunately those who have been entrusted with their execution are vividly aware of the bearing of their work not only upon the well-being of the people in regional areas but also upon the standard of living of the entire Nation. They are, therefore, concerning themselves with the conservation and use of every economic resource. Thus there has arisen the apparent paradox that the more comprehensive and vast the over-all plan the more intense is the concern for little things, for the conservation of little waters, for example, and the wise utilization of small water powers.

What contribution may we reasonably expect the planned utilization of small water powers to make not only toward the cost of the major undertakings but also toward the diffusion of individual comfort and well-being and the stimulation of individual enterprise within their larger social and technological framework?

We no sooner ask the question than we are compelled to acknowledge the fact that the extent of potential small water powers in the United States has never been accurately determined. As indicating the chronology of the cycle outlined above, it is noteworthy that since 1921 the United States Geological Survey has omitted from its utilized power listings, as practically negligible, all separate installations which deliver less than 10,000 kilowatt-hours per minimum month, nearly equivalent to 100 horsepower of installed capacity under usual practice; and that our best sources of primary information relative both to the number and distribution of small water powers are the Thirteenth, Twelfth, and Tenth Censuses of the United States, those of 1910, 1900, and 1880, even though they

[1] Written for the Third World Power Conference, Washington, D. C., 1936.
[2] Chief, Soil Conservation Service.

fail to distinguish between small-power sites and small installations. The early use of water power at practically all prominent falls thus far utilized in this country inevitably, owing to the still primitive state of technological development, was through small installations. Even on the Niagara the average horsepower per mill as shown in table I based on the Tenth Census was 151, less than the reported horsepower per site on the New York State canals. And yet these tables do serve to convey an approximately accurate idea both of the number of small water powers and of their remarkably wide distribution throughout the 48 States and the District fo Columbia. An analysis of these statistics would seem to justify the inference that excluding those which might properly be classified as inaccessible or requiring too difficult construction, or lacking valley lands, dependable all-year water supply, and other facilities for establishing and maintaining homes and minor industries in the vicinity, the number of available sites deserving consideration in any comprehensive plan for the rational use of small water powers exceeds 50,000. This estimate is particularly supported by table II, which shows that the number of water wheels used in manufacture alone in 1879 was 55,404, and this at a time when extensive frontiers were but sparsely settled, and when no entire river system even approached complete development. Whether we should agree to define a small water power as of a dimension of 1,000 horsepower or less, or of 100 horsepower or less, it is obvious that our small powers in the aggregate represent a potential running into the millions of horsepower.

TABLE I.—*Selected data on water power from the Tenth Census of the United States, 1880; Water Power, pt. I, p. xxxix, et seq., also pt. II*

River	Drainage area (square miles)	Number of power sites	Number of mills	Horsepower used	Average horsepower		Maximum power site	
					Per site	Per mill	Capacity in horsepower	Number of mills
Coast streams of Maine	...	450	1,491	86,139	192	58	7,800	6
Coast streams of New Hampshire	...	64	168	11,235	176	67	3,475	2
Merrimack	4,916	24	46	39,937	1,662	867	11,314	4
Tributaries of the Merrimack	...	397	878	48,904	123	56	4,100	1
Coast streams south of the Merrimack	...	251	794	50,451	201	64	6,415	21
Connecticut	10,924	761	2,298	118,026	156	51	6,315	17
Hudson, N. Y	13,366	578	1,646	82,910	140	49	3,048	19
Niagara	...	...	27	4,083	...	151	...	...
Huron, Mich	950	12	20	1,965	163	98	400	1
Black, N. Y	1,857	58	212	13,029	224	64	3,557	8
Oswego, N. Y	5,013	238	748	31,488	132	41	1,930	15
Geneseo, N. Y	2,496	111	349	13,898	125	40	1,520	17
New York State canals, exclusive of feeders	...	14	40	2,391	171	60	1,421	22
Pennsylvania State canals	...	...	...	2,950	...	...	...	...
Ohio State canals	...	71	150	6,618	93	44	800	5
Passaic, N. J	962	76	155	7,365	97	47	660	3
Delaware, including Schuylkill	12,012	427	2,110	55,855	131	26	2,069	89
Susquehanna	26,233	566	2,943	70,283	124	24	3,666	168
Potomac	14,500	156	1,007	18,790	121	18	1,710	84
James	9,700	145	469	13,323	92	29	700	1
Savannah	6,850	86	394	11,776	137	30	3,650	15
Allegheny	11,107	197	715	19,204	98	27	848	29
Alabama	23,700	124	630	10,169	82	16	900	7
Appalachicola	19,580	147	604	13,009	89	22	2,000	3
Monongahela	7,625	76	289	5,845	77	20	350	1
Muskinghum, Ohio	7,740	63	226	5,742	91	25	673	15
Kansas	59,750	89	146	6,561	74	45	255	4
Missouri River Basin, total	527,000	301	607	23,557	78	39	1,284	26
Arkansas	108,143	147	281	7,096	48	25	352	6
Red River	92,700	23	39	778	33	20	102	3

In the report of the Water Planning Committee already referred to, the authors wisely warn all concerned that to recommend for any river basin an inclusive water plan without exhaustive study of adequate data bearing on all phases of the many problems involved would be most illogical, would invite and deserve severe criticism, would involve economic waste, and might preclude the formulation of a well-balanced plan later. In the case of small water powers as in that of rivers to which they are tributary, fundamental data, the consideration of which is a prerequisite to effective planning and wise utilization, still are lacking in greater or less degree on both the surface and underground waters of most drainage areas throughout the country. In spite of the important position which small waters and more especially small water-power installation held in our earlier history, we must recognize that from the point of view of the emerging conception of over-all planning, multiple use, and integrated conservation and utilization of all natural resources, we are at a pioneering stage with respect to our knowledge of small water powers and the place which they should rightfully occupy in our master plans.

In examining available statistical sources, we are struck by their exclusive preoccupation with water as power, just as in the case of municipal engineers we are struck by their exclusive preoccupation with water supply, and in the cases of great flood-control works with the speeding up of run-off to the exclusion of power development and often with little consideration of soil conservation and use. Nevertheless, the data supplied by the Tenth, Twelfth, and Thirteenth Census reports have great value both in themselves and as guides to future research. Table III provides a comparison of power utilized in manufactures as reported by the census in 1870 and 1880, with geographical distribution by States. It is there shown that the growth of water power and steam power in the manufacturing field during the previous decade had been about 8 percent and 80 percent, respectively. Table I provides further details through selected data on water power relating to representative river and canal systems, and indicates that nearly all would be classed as small water powers if 1,000 horsepower is accepted as the basis of classification and due account is taken of the distinction between small water powers and small water-power installations.

Table IV shows the trend of water-power utilization in manufactures from 1869 to 1909, with regional distribution. It appears from these data that a steady growth continued throughout the 40-year period of record, with a total increase of 61 percent. Table

TABLE II.—*Water power utilized in manufactures in the United States* [1]

Year	Horsepower	Number of water wheels	Average horsepower per wheel	Total developed water power		
				Number of plants	Number of water wheels	Total horsepower
1869	1,130,431	51,018	22	...	...	1,150,000
1879	1,225,379	55,404	22	...	...	1,250,000
1889	1,225,045	...	...	...	...	1,300,000
1899	1,454,112	23,099	63	...	...	...
1902	...	...	...	...	...	2,050,000
1904	1,647,880	20,992	79	...	...	...
1907	...	...	...	...	...	3,250,000
1909	1,822,888	21,282	86	31,537	52,827	3,870,000
1914	1,826,443	18,065	101	...	...	5,790,000
1919	1,765,263	13,980	126	...	...	7,590,000
	Omitting all plants less than 100-horsepower capacity after 1921					
1923	1,803,000	9,293	194	...	...	9,090,000
1925	1,800,000	8,393	214	3,355	...	11,180,000
1927	1,598,000	7,594	210	3,390	...	11,720,000
1929	1,559,000	6,523	239	...	...	13,571,530
1930	...	...	...	...	...	13,807,778
1931	...	...	...	...	...	14,884,667
1932	...	...	...	...	...	15,562,805
1933	...	...	...	...	...	15,817,941
1934	...	...	...	...	...	15,913,451
1935	...	...	...	3,117	...	16,075,307
1936	...	...	...	3,067	...	16,079,407

[1] (*a*) Tenth Census, 1880, Water Power, pt. I, p. xii; (*b*) Abstract of the Census of Manufactures, 1919, p. 460; (*c*) U. S. Census, 1929, Mfg., pt. I, p. 112; (*d*) The Economics of Water Power Development, 1928, Walter Henry Veskuil; (*e*) U. S. Geological Survey Water Supply Papers No. 579, p. 206 (1928); and No. 234, p. 29 (1909).

TABLE III.—*Reproduction from Tenth Census of the United States, Water Power, pt. I, 1, pp. xii-xiii; Power Utilized in Manufactures by Prof. George F. Swain*

	Water power			Steam power			1870		1880	
	Total in 1870	Total in 1880	Increase	Total in 1870	Total in 1880	Increase	Water power	Steam power	Water power	Steam power
	Horsepower	*Horsepower*	*Percent*	*Horsepower*	*Horsepower*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Total in the United States	1,130,431	1,225,379	8.40	1,215,711	2,185,458	79.77	48.18	51.82	35.93	64.07
Alabama	11,011	11,797	7.14	7,740	15,779	103.85	58.72	41.28	42.78	57.22
Arizona	10	160	1,500.00	80 (35)	370	957.14	11.11	88.89	30.19	69.81
Arkansas	1,545	2,024	31.00	6,101	13,709	124.70	20.21	79.79	12.86	87.14
California	6,877 (4,381)	4,850	(1)	18,493 (17,072)	28,071	64.43	27.11	72.89	14.73	85.27
Colorado	792 (742)	1,849	149.19	1,433 (761)	3,953	419.45	35.60	64.40	31.87	68.13
Connecticut	54,395	61,205	12.52	25,979	57,027	119.51	67.68	32.32	51.77	48.23
Dakota	76	803	956.58	248	1,421	472.98	23.46	76.54	36.11	63.89
Delaware	4,220	4,785	13.39	4,313	10,643	146.77	49.46	50.54	31.02	68.98
District of Columbia	1,100	880	(1)	789	2,263	186.82	58.23	41.77	28.00	72.00
Florida	528	939	77.84	3,172	6,208	95.71	14.27	85.73	13.14	86.86
Georgia	27,417 (27,356)	30,067	9.91	10,826 (10,811)	21,102	95.19	71.69	28.31	58.76	41.24
Idaho	295 (92)	1,136	1,134.78	311 (191)	546	185.86	48.68	51.32	67.54	32.46
Illinois	12,953	17,445	34.68	73,091	126,843	73.54	15.05	84.95	12.09	87.91
Indiana	23,518	21,810	(1)	76,851	109,960	43.08	23.43	76.57	16.55	83.45
Iowa	14,249	20,363	42.91	25,298	33,858	33.84	36.03	63.97	37.56	62.44
Kansas	1,789	7,611	325.43	6,360	13,468	111.76	21.95	78.05	36.11	63.89
Kentucky	7,640	9,012	17.96	31,928	45,917	43.81	19.31	80.69	16.41	83.59
Louisiana	142	90	(1)	24,924 (6,628)	11,256	69.82	.57	99.43	.79	99.21
Maine	70,108	79,717	13.76	9,465	20,759	119.32	88.11	11.89	79.34	20.66
Maryland	18,461	18,043	(1)	13,961	33,216	137.92	56.94	43.06	35.20	64.80
Massachusetts	105,854	138,362	30.71	78,502 (78,450)	171,397	118.48	57.42	42.58	44.67	55.33
Michigan	34,895	34,395	(1)	70,956	130,352	83.71	32.97	67.03	20.88	79.12
Minnesota	13,054	28,689	119.77	7,085	25,191	255.55	64.82	35.18	53.25	46.75
Mississippi	2,453	3,449	40.60	10,019	15,001	49.73	19.67	80.33	18.69	81.31
Missouri	6,644	8,162	22.85	48,418	72,587	49.92	12.07	87.93	10.11	89.89
Montana	795 (611)	954	56.14	822 (226)	544	140.71	49.17	50.83	63.68	36.32
Nebraska	1,446	5,495	280.01	1,865	2,999	60.80	43.67	56.33	64.69	35.31
Nevada	2,538 (370)	108	(1)	6,007 (636)	608	(1)	29.70	70.30	15.08	84.92
New Hampshire	68,291	69,155	1.27	8,787	18,595	111.62	88.60	11.40	78.81	21.19
New Jersey	25,832	27,066	4.78	32,307	72,792	125.31	44.43	55.57	27.10	72.90
New Mexico	659 (623)	932	49.60	252 (103)	427	314.56	72.34	27.66	68.58	31.42
New York	208,256 (208,106)	219,348	5.40	126,107	234,795	86.19	62.28	37.72	48.30	51.70
North Carolina	26,211 (26,200)	30,063	14.74	6,941 (6,816)	15,025	120.44	79.06	20.94	66.68	33.32
Ohio	44,746	38,641	(1)	129,577	222,502	71.71	25.67	74.33	14.80	85.20
Oregon	5,806 (5,766)	9,255	60.51	2,471 (2,451)	4,334	76.83	70.15	29.85	68.11	31.89
Pennsylvania	141,982	110,276	(1)	221,936	402,132	81.19	39.01	60.99	21.52	78.48
Rhode Island	18,481	22,240	20.34	23,546	41,335	75.55	43.97	56.03	34.98	65.02
South Carolina	10,395 (10,386)	13,873	33.58	4,537 (4,487)	11,995	16.73	69.62	30.38	53.63	46.37
Tennessee	19,514	18,564	(1)	18,467	33,388	80.80	51.38	48.62	35.73	64.27
Texas	1,830	2,508	37.05	11,214	28,026	149.92	14.03	85.97	8.21	91.79
Utah	2,169	3,535	62.98	331 (319)	1,154	261.76	86.76	13.24	75.39	24.61
Vermont	44,897	52,226	16.32	6,425	11,088	72.58	87.48	12.52	82.49	17.51
Virginia	41,202	37,464	(1)	8,410	19,710	134.36	83.05	16.95	65.53	34.47
Washington	1,412	1,185	(1)	1,411	3,210	127.49	50.02	49.98	26.96	73.04
West Virginia	10,195	9,454	(1)	17,136	28,456	66.06	37.30	62.70	24.94	75.06
Wisconsin	33,714	45,356	34.53	30,509	60,729	99.05	52.50	47.50	42.75	57.25
Wyoming	34 (0)	38	....	310 (245)	717	192.65	9.88	90.12	5.03	94.97

1 Decrease.

NOTE.—In cases where 2 figures are given for the steam or water power of a State in 1870, those not enclosed in parentheses are the ones returned. Those in parentheses are the figures used in computing the percentages of increase and have been derived from the former by subtracting power used for purposes which in 1880 were not classified under manufactures. The table thus refers to power used in manufactures as classified in 1880.

II shows the trend in water-power utilization in manufactures from 1869 to 1929, together with the number of water wheels and average horsepower per wheel for each census there recorded, the later ones being at intervals of less than 10 years. These data disclose a fairly gradual rise up until 1914, thence a slight decline in total horsepower, while the number of water wheels decreased from more than 50,000 to 6,523 and the average horsepower per wheel progressively increased from 22 to 239. To provide a comparison, fragmentary data are added in the last three columns to show the growth of total developed water power during recent years in relation to use in manufactures.

Table V shows the distribution of water power used for flour- and grist-mill products in relation to the total power required for this industry—451,378 horsepower out of a total of 1,016,859, or 44 percent being supplied from water wheels with an average capacity of 21.7 horsepower in 1900. Reference to the second column of table II shows that for 1899 the total water power utilized in manufactures was more than three times that devoted to flour- and

TABLE IV.—*Water power used in manufactures from water wheels and motors, owned power only, from Thirteenth U. S. Census, 1910; pt. VIII, p. 348 (expressed in horsepower)*

Region	1869	1879	1889	1899	1904	1909
New England	362, 026	422, 905	497, 031	619, 209	659, 071	757, 332
Middle Atlantic	376, 070	356, 690	331, 964	410, 173	514, 951	470, 488
East North Central	149, 826	157, 647	155, 245	171, 077	194, 871	208, 441
West North Central	37, 258	71, 123	60, 005	51, 999	63, 659	86, 330
South Atlantic	139, 729	145, 568	145, 397	124, 830	137, 018	183, 158
East South Central	40, 618	42, 822	34, 850	25, 107	24, 193	29, 315
West South Central	3, 517	4, 622	4, 552	2, 760	3, 236	3, 108
Rocky Mountain	7, 292	8, 712	6, 779	18, 161	18, 319	21, 543
Pacific	14, 095	15, 290	19, 222	30, 796	32, 562	63, 173
United States	1, 130, 431	1, 225, 379	1, 255, 045	1, 454, 112	1, 647, 880	1, 822, 888

grist-mill products alone and represented fully three-fourths of the total developed water power; while in 1909, manufactures utilized less than half and in 1929 about one-ninth of the total, thereby reflecting the growth of electrical power and transmission systems as the principal factor in recent water-power development.

The character and extent of recent utilization of small water powers in the United States encompass the entire range of activities to which such energy is applied in either large or small quantities. In this connection it should be noted that the apparent reduction in the number of utilized water powers as shown in table II is partly attributable to the omission of all plants with less than 100-horsepower capacity after 1921—an unfortunate omission for which appropriate allowance must be made.

As has already been suggested, that omission is symptomatic of the difficulty which even highly trained men deeply concerned with the general ideals of conservation have found in escaping single-use preoccupations and in developing a comprehensive view of all the factors which must be interrelated if the highest economic and social interests of the Nation are to be effectively served. Among innumerable possible examples of that difficulty, two are here cited as illustrating strikingly contrasted stages in the evolution of our attitude toward stream regulation and use.

In the Muskingum Valley, Ohio, the best available census statistics and estimates account for 253 water powers utilized for grist and saw mills in 1880, 90 in 1904, and 14 today. It is a notable fact that the flood-control reservoirs now under way in the Muskingum conservancy district include no provision for power development, even though considerable head and storage capacity are available. As a result of the abandonment or absorption of small water powers by these reservoirs in the Muskingum Valley, some of the feed grinding for farm use is now done by portable engine-driven mills mounted on trucks. Where conservancy districts are organized for flood control solely, as in both the Miami and Muskingum districts in Ohio, the paramount consideration is protection of lives and property, and whatever concession is made toward water conservation after the flood crest has passed, is in the nature of an uneconomic compromise. It would require legislative amendment of their basic charters to permit these conservancy districts to develop their potential water powers; and any other agency seeking to sponsor power enterprises would find it impossible to realize full values from their investment, until joint agreements are worked out to coordinate such needlessly conflicting interests as power development and flood control. Actually, official estimates show that the best of the Muskingum sites could produce power well below the prevailing market price without interference with their function in flood control. That the authorities in this district are recovering from the earlier terrified preoccupation with flood control is indicated by an expression in an Ohio water conservancy board report which recommends repeal of a section of the General Code of the State law: "This law (forbidding the obstruction of water courses) has been so ruthless in its operation that dams have been blown out and streams have been straightened and dredged to get rid of the water as fast as possible."

In contrast with the picture in the Muskingum conservancy district is that of the condition of reservoirs in the southern half of the country where the preoccupation has been with storage without due consideration of land conservation and soil erosion. The importance of sedimentation as a present-day factor in reservoir maintenance in the various type regions of the country has been made a special subject of systematic investigation by the Research Section of Sedimentation and Hydraulic Studies of the Soil Conservation Service during the greater part of the past 2 years. To date, detailed capacity surveys have been made of some 30 reservoirs in the southern half of the United States to determine the actual volumes of silt that have accumulated in known periods of time. Also, reconnaissance examinations have been made of other reservoirs throughout the same region. Although these studies have dealt, for the most part, with reservoirs somewhat larger than small plants usually require, the results, with respect to rates of silt production from watershed areas under characteristic present-day erosion, are broadly applicable to the small reservoirs problem. This is particularly true of investigations made in the southeastern section of the country, where significant contrasts were found in rates of reservoir silting in the largely deforested and cultivated Piedmont agricultural region on the one hand, and in the adjacent forest-protected watersheds of the Appalachian Mountain province on the other.

Completely Filled Reservoirs

Practically all small reservoirs in the Piedmont and many others of major size that are more than a few decades old were found to be completely filled, except for a normal alluvial stream channel through the region of the original pond (fig. 1).

Typical of the smaller reservoirs are those of Deep River, downstream from the municipal reservoir of High Point, N. C.; Gil Reath's Mill on a tributary of Tiger River, South Fork near Greer, S. C.; Jenkins Mill on Glade Creek northeast of Gainesville, Ga.; and Barrett Mill dam on East Sandy Creek, Athens, Ga., shown in figure 2. Detailed description of the individual sites would be tedious repetition, for the most part, of complex histories of small dams having been constructed, filled, raised, and filled again. At the present time most of these small dams are practically without useful storage, and consequently, reduced in power capacity during low-water season to the ordinary discharge from small drainage basins.

In all the Piedmont there are literally scores of such smaller reservoirs, with dams 10 to 30 feet (3.1 to 9.2 meters) high, equipped to generate various amounts of power running generally from 15 or 20 upwards to 75 or 80 horsepower. Altogether, these smaller plants generate a really important aggregate power. Their intimate distribution and service among the rural communities of the Southern States for grist-mill and other local uses, makes their gradual deterioration particularly distressing to a large proportion of the population.

Some of the larger reservoirs filled to the point of practically complete elimination of storage as a factor of power production, are listed in table VI. An appreciation of the magnitude and rapidity of loss of storage capacity assets of these power plants can be conveyed better, perhaps by table VI than by detailed description of each individual case. The height of dam, where given, relates closely in most cases to original storage depth and capacity. The life in years given in the table is the approximate time required for complete filling, although in several instances the reservoir had

been nearly filled in shorter time, and stream-borne materials, including sand, had been occasionally passing over the dams for several years.

All of those dams are first-class concrete or masonry structures, and represent large initial investments. More than half are 30 to 50 feet in height and originally ponded water for distances of 4 to 7 miles. The fate of these dams indicates clearly the serious inroads already made upon developed power resources of the southern industrial region by accumulation of erosional waste, and the magnitude of the continuing menace to other power developments that have been or may be made in the erodible Piedmont region.

Appalachian Mountain Region

In contrast with the silt-filled reservoirs of the Piedmont, there are listed in table VII some of the reservoirs of the Appalachian Mountain region which have survived with negligible loss of storage capacity, in spite of steeper slopes. The soils of both regions are derived principally from granite and gneiss, of closely similar depth of decay and erodibility. The differences in land use must account for the different rates of sedimentation; the virgin forests or naturally reforested lands with only occasional agricultural plots of the mountain slopes proving to be more stable than the gentler slopes of cultivated Piedmont lands with the protective cover largely removed.

TABLE V.—*Production of flour- and grist-mill products—Distribution of water power in the United States, 1900, from Twelfth Census Bulletin 199, pp. 20 to 31*

State	Number of establishments	Power			
		Number reporting	Total horsepower	Number of water wheels	Horsepower
Alabama	781	780	14, 436	698	9, 279
Arizona	11	11	604	6	292
Arkansas	410	411	10, 091	152	2, 448
California	124	123	11, 058	36	1, 412
Colorado	60	60	4, 819	19	1, 020
Connecticut	208	208	6, 930	200	4, 597
Delaware	83	83	3, 803	106	2, 484
District of Columbia	9	9	636	2	280
Florida	95	95	1, 507	57	762
Georgia	1, 123	1, 114	25, 037	1, 244	18, 410
Idaho	34	34	1, 833	22	816
Illinois	871	866	46, 467	134	3, 853
Indiana	897	896	51, 757	369	9, 735
Indian Territory	61	61	2, 278	8	202
Iowa	702	693	33, 695	490	11, 554
Kansas	533	522	31, 386	194	8, 207
Kentucky	1, 145	1, 144	31, 086	508	8, 103
Louisiana	69	57	1, 102	2	25
Maine	227	225	8, 619	251	6, 492
Maryland	407	411	14, 182	439	8, 035
Massachusetts	231	227	9, 536	229	6, 464
Michigan	765	765	43, 960	621	19, 780
Minnesota	512	511	69, 560	265	23, 209
Mississippi	225	224	3, 950	104	1, 178
Missouri	1, 145	1, 135	47, 947	317	6, 291
Montana	20	18	1, 451	22	931
Nebraska	305	304	16, 649	208	7, 875
Nevada	11	11	463	11	373
New Hampshire	149	149	7, 249	220	5, 922
New Jersey	354	353	13, 975	403	9, 712
New Mexico	35	35	1, 086	24	519
New York	1, 513	1, 507	90, 347	2, 131	58, 384
North Carolina	1, 773	1, 770	37, 504	2, 058	28, 658
North Dakota	97	97	5, 930	16	568
Ohio	1, 150	1, 150	65, 489	615	15, 640
Oklahoma	55	52	3, 377	1	20
Oregon	153	152	8, 390	132	5, 540
Pennsylvania	2, 719	2, 709	96, 531	3, 017	55, 812
Rhode Island	47	41	1, 993	32	921
South Carolina	556	553	9, 705	424	5, 842
South Dakota	120	120	6, 546	31	1, 163
Tennessee	1, 618	1, 618	37, 672	1, 301	19, 255
Texas	289	283	13, 640	48	1, 626
Utah	80	80	3, 688	82	2, 798
Vermont	211	213	13, 111	408	11, 990
Virginia	1, 726	1, 720	32, 916	1, 833	31, 077
Washington	85	85	5, 816	44	2, 387
West Virginia	737	734	16, 865	451	6, 253
Wisconsin	717	717	47, 713	775	22, 887
Wyoming	10	10	465	6	297
United States	25, 258	24, 147	1, 016, 859	20, 766	451, 378

Average horsepower per wheel, 21.7.

TABLE VI.—*Reservoirs of the Piedmont agricultural region—Examples of filled reservoirs in various sections of South Carolina and Georgia*

River	Reservoir	Height of dam (feet)	Age (years)
Broad	Gaston Shoals, S. C	39	28
	Parr Shoals, S. C		
Enoree	Van Patten Shoals, S. C	14	26
	Riverdale Mill, S. C		
Saluda	Saluda, S. C	44	29
	Holloday, S. C	37	29
Savannah	Portman Shoals, S. C	42	36
	Near Anderson, S. C		
	Gregg Shoals, S. C	14	27
	Near Iva, S. C		
Oconee	Tallassee, Ga	30	32
	Mitchells Bridge, Ga	15	36
	Barnett Shoals, Ga	45	23
Yellow	Millstead Dam		
Chattahoochee	Dunlop, Ga	36	30
	Morgan Falls, Ga	50	30
	Langdale, Ga	14. 5	28
	Riverview, Ga	9	29
Total		388. 5	383
Average		29. 8	29. 4

Rates of Silting Indicated

Prior to the investigations by the Soil Conservation Service during the past 2 years, capacity surveys to determine rates of silting had been made of some 25 American reservoirs. Among these reservoirs only 10 are of basin type, with original capacities large enough to permit practically complete natural desilting of all inflowing water and so to afford a practical index to comparative average rates of sediment delivery from their watersheds during periods of record. Table VIII presents a summary of the data on these reservoirs, including computations of average rates of silt accumulation per square mile of watershed area.

It is to be noted that these records of earlier reservoir surveys relate almost exclusively to the relatively dry southwestern sections of the country where flood flows of streams are generally conspicuously charged with silt and where the seriousness of sedimentation as a limiting factor of reservoir life has long been widely recognized. The recent extension of reservoir studies into other type regions of the country indicates that the sedimentation factor is fully as important, if not more so, in humid regions wherever vegetative restraints have been removed or weakened sufficiently to introduce accelerated erosion. This is shown by table IX which summarizes the significant data of reservoir surveys by the Soil Conservation Service in the southwestern, south central, and southeastern sections of the country.

The foregoing data show that the present rates of sedimentation in reservoirs, both large and small, throughout broad regions of the country generally range from a quarter to one or more acre-feet of silt per square mile of tributary watershed. Although these tabulations, when segregated for arid and humid regions, respectively show average annual silting rates of 1.25 or 0.65 acre-foot per square mile of drainage area, it is apparent that the data are not strictly comparable, but only approximately so.

The foregoing and related data from the recently completed country-wide reconnaissance survey of erosion conditions, carried out by the Soil Conservation Service, shows that accelerated erosion, in one form or another, is almost universally prevalent in all but the more sparsely populated regions of sloping lands, and that the sedimentation factor has increased accordingly. In considering the question of present-day possibilities of small water powers,

Table VII.—*Reservoirs of the southern Appalachian Mountain region—Examples of reservoirs in various sections of North Carolina and Georgia which have survived with negligible loss of storage*

River	Reservoir	Height of dam (feet)	Age (years)
Little	Little River near Brevard, N. C.		25
Green	Green River near Tuxedo, N. C.		18
Upper Catawba	Bridgewater or Lake James near Morgantown, N. C.	135	17
Upper Tugalo	Burtin	114	9
	Raburn		
	Nacoochee	63	10
	Tallulah near Tallulah Falls, Ga		22

we therefore cannot rely solely upon the early day history of such power in this country. We must also take into account the actual discharges and silt loads that our streams now carry. Outside of limited regions that are as yet but little affected by human influences, and by the same token are generally unfavorable to power developments because of lack of suitable populations to be served, the accentuation of the sedimentation factor by unchecked erosion appears to militate selectively against the smaller water-power enterprise.

Fortunately, the measures of erosion control that are coming more and more into justified use for land conservation alone are necessarily effective also in reducing direct surface run-off and silt production, while increasing infiltration and ground-water storage. In many cases and perhaps quite generally in agricultural regions, the small water-power possibilities are thus directly integrated with the problems of salvage and conservation of land and water resources. Under these circumstances it would seem eminently in order to consider these two problems together wherever they can be served in common by research and by practical erosion-control work on the watersheds involved.

Whether we consider the story of flood control as illustrated in the Muskingum conservancy district, or the silting of reservoirs, it becomes increasingly clear that we must develop a new approach to problems of the conservation and utilization of little waters and small water powers, and that that approach must have reference to the planned conservation, development, and use of all the resources of entire drainage areas. We must see flood control in relation to power, power and water storage in relation to soil conservation, soil conservation in relation to forests, grassy ground cover, and the conservation of the natural headwater reservoirs upon which the flow both of surface and subsurface waters so intimately depends.

Now, it happens that there is no drainage area in America in which the interdependence of all these elements has been so fully considered as that under the jurisdiction and influence of the Tennessee Valley Authority, and it is significant that there are few if any comparable areas in which there are so many small water powers in use and in process of development, although the facts are only in part attributable to the comparatively recent activities of the Authority. It must be remembered, however, that the spirit and direction of those activities have had their precursors in the work of the land-grant colleges and the universities of the Tennessee Valley States, many members of whose staffs are today directly and cooperatively engaged in the work of the T. V. A.

In contrast to decline in the utilization of small water powers in the Muskingum area, the Tennessee Valley has about 1,700 small water-power plants of 100-horsepower or less capacity, devoted to a wide variety of farm, household, and industrial uses. Of these plants, 912 are in Tennessee, 404 in North Carolina, 162 in Virginia, 120 in Georgia, and 81 in Alabama, according to information furnished by Prof. Sherman M. Woodward, chief water control planning engineer of the Tennessee Valley Authority.

The main uses to which the small water powers of Tennessee Valley are applied are the following:

(A) One- to five-family mill, used for grinding meal but not for producing flour.

(B) Small community mill, used for grist and feed grinding, occasionally for sawmill operation, and for generating electricity for household use at night.

(C) One-family electric plants, mostly using either belt-driven or geared direct-current generators driven by the water wheels.

(D) Small community electric plants, the outgrowth from what were originally one-family plants. To take care of the peak demands where capacity or stream flow is otherwise insufficient, it is common practice to install a set of storage batteries that can be charged at a constant rate and discharged at the will of the owners.

(E) Mineral mills, driven by either water wheels or by turbines, utilized for pulverizing either mica or clay, and often utilizing part of the power for electric lighting.

In table III it appears that only 18,564 horsepower were utilized in the entire State of Tennessee for manufactures in 1880. If the average capacity per wheel was 22 horsepower, as reported for that

Table VIII.—*Silting records of reservoirs of higher capacity inflow ratio*

Reservoir	Stream	Location	Original storage capacity per square mile of drainage area (acre-feet)	Annual silt accumulation per square mile of drainage area (acre-feet)	Percentage of original capacity per year depleted by silting (percent)	Period
White Rock	White Rock Creek	Dallas, Tex	159.28	1.19	0.69	1923–28
				1.36	.85	1910–35
Elephant Butte [1]	Salt River	Hot Springs, N. Mex	100.29	.83	.83	1915–25
				.52	.52	1925–35
Roosevelt	do	Roosevelt, Ariz	284.25	1.16	.41	1910–25
Lake Michie	Flat River	Durham, N. C	74.53	.17	.16	1926–30
				.26	.36	1926–35
Lake Worth	West Fork Trinity River	Fort Worth, Tex	25.20	.57	2.24	1915–28
Lake McMillan	Pecos River	Carlsbad, N. Mex	4.09	.08	2.14	1894–15
				.0159	.38	1915–25
				.0095	.23	1925–32
Zuni	Zuni River	Black Rock, N. Mex	31.62	1.10	3.48	1907–17
				1.20	3.83	1917–27
Sweetwater	Sweetwater River	Sunnyside, Calif	99.60	.90	.90	1888–95
			121.17	.74	.61	1895–16
			200.92	.48		1916–27
Lake Cabot	San Leandro River	Oakland, Calif	404.70	1.73	.42	1875–23
Gibraltar	Santa Inez River	Santa Barbara, Calif	73.00	.80	.55	1920–25
				1.25	.91	1925–31
				3.00	2.44	1931–34

[1] Period of subnormal rainfall and increased silting in the valley above the reservoir.

Table IX.—*Reservoirs surveyed by Soil Conservation Service 1934 to 1936*

Name of reservoir	Location	Storage per square mile of drainage area (acre-feet)	Annual silt accumulation per square mile of drainage area (acre-feet)	Percent of original capacity per year depleted by silting (percent)	Period
Lake Michie	Durham, N. C.	74.53	0.26	0.36	April 1926 to January 1935.
University Lake	Chapel Hill, N. C.	70.90	.80	1.14	June 1932 to April 1935.
Greensboro Reservoir	Greensboro, N. C.	39.80	.31	.78	February 1923 to August 1934.
High Point Reservoir	High Point, N. C.	72.00	.60	.84	August 1927 to August 1934.
Lake Concord	Concord, N. C.	316.07	2.05	.65	March 1925 to May 1935.
Spartanburg Reservoir	Spartanburg, S. C.	29.30	.62	2.10	May 1926 to July 1934.
Lloyd Shoals Reservoir (Ocmulgee River)	Jackson, Ga.	81.35	.41	.51	December 1910 to March 1935.
Rogers Reservoir	Rogers, Tex.	300.00	5.68	1.90	September 1922 to September 1934.
Lake Waco	Waco, Tex.	23.15	.57	2.48	April 1930 to March 1935.
White Rock Reservoir	Dallas, Tex.	159.28	1.36	.86	1910 to 1935.
Guthrie Reservoir	Guthrie, Okla.	228.91	2.35	1.03	October 1920 to May 1935.
Boomer Lake	Stillwater, Okla.	307.98	1.82	.59	March 1925 to June 1935.
Elephant Butte Reservoir (Rio Grande)	Hot Springs, N. Mex.	100.29	.68	.68	January 1915 to April 1935.
San Carlos Reservoir (Gila River)	Coolidge Dam, Ariz.	92.15	.43	.46	October 1928 to February 1935.

year in the entire United States in table II, this would represent only about 850 mills run by water power; or if the average capacity was as low as 10 horsepower per wheel, the number of plants was 1,856. It may be inferred, therefore, that the general decline in utilization of small water powers since 1880, as noted elsewhere herein, has not extended to the Tennessee Valley. In fact, along with recent extensive developments of large power projects, there is an awakened interest in the possibilities of small water powers. During the past few years the number of new plants and rehabilitations of old ones seems to have about kept pace with the plants abandoned.

It is significant that the development of large power plants and the widespread distribution of electric energy seems to stimulate the demand for utilization of available sites for small water powers and to enhance their value. Indeed, from the point of view of the rationally planned utilization of small water powers, either as units in an electric-utility distribution system or in projects for community or rural development, the higher significance of the facts in the Tennessee Valley is that they are there being envisaged in the relation to the controlled conservation and development of the total resources of an entire drainage area, and specifically in relation to the standard of living of the people not only in the valley, but throughout the Nation.

Crude and inadequate as our statistical information as to the extent and aggregate volume of small water powers is, the answer to the question as to the economic practicability and the social advantage of their planned utilization is not in doubt; but the measure of their ultimate value will depend upon the ability of engineers and economists and of supporting public opinion to grasp the interdependence of soil conservation, flood control, water supply, and power development. The problem of the effective utilization of small water powers, like the problem of the conservation of little waters, is not an isolated problem; it is inherent in the problem of total resource conservation and use, upon the wise solution of which the permanence of our American civilization depends.

Summary

The reawakening of interest in little waters and small water powers is a significant example of a profound transformation of the traditional American attitude toward conservation of natural resources. We are becoming land- and water-conscious in a new sense.

Small water powers played a major role in the colonial history of the industrial East, but their recognized importance was greatly diminished by the coming of coal, the concentration of population in manufacturing centers, and the shifting of interest from water power to water supply. The cycle which the steam engine effected through concentration in the East, the steam locomotive induced through dispersion of population over western plains.

The disastrous effects upon the conservation of little waters and the use of small water powers resulting from narrow preoccupation with single phases of stream regulation, whether water supply, flood control, or small water storage is illustrated by the threat of water famine in great metropolitan centers, the neglect of power development in such flood-control methods as those followed in the Muskingum conservancy district, and the sedimentation of important reservoirs especially throughout the southern region. These facts lend particular interest to the situation with respect to the survival and development of small water powers in the Tennessee River drainage area now under the control of the Tennessee Valley Authority.

Inadequate as our statistical information is, and urgent as is the need for comprehensive research, we are justified by available data in placing the number of small water power sites at more than 50,000 in estimating their aggregate potential in the millions of horsepower. But their effective utilization depends upon the ability of engineers, economists, and supporting public opinion to grasp the interdependence of water supply, flood control, soil conservation, and power development. The utilization of small water powers is inherent in the problems of total resource conservation and use.

WIND AND WATER EROSION

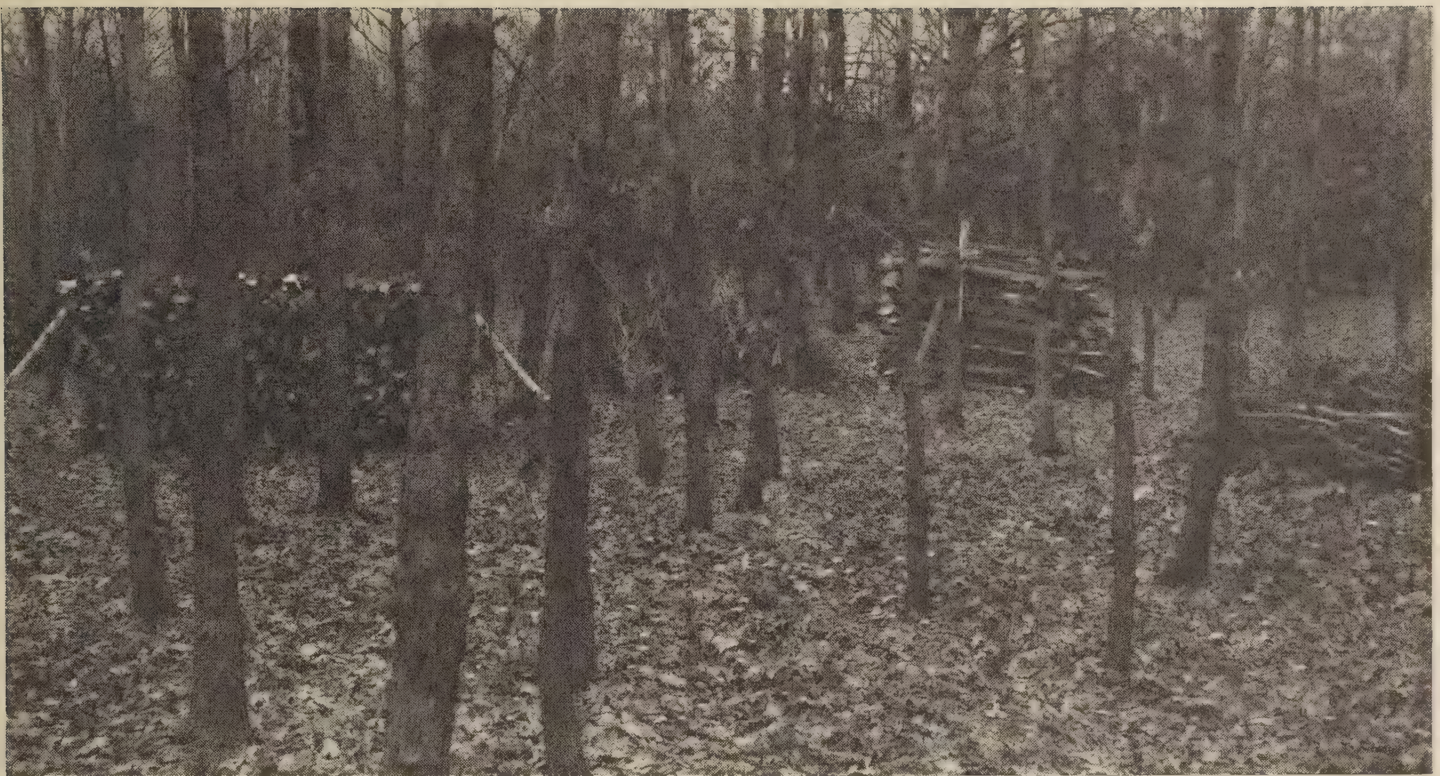
Twenty counties, lying in a compact area about the meeting place of the five State-boundary lines in the Southern Plains region, have been surveyed in considerable detail by the Soil Conservation Service. Approximately 25,000 square miles are involved in the area studies. It was found that the land affected to a serious degree by all types of erosion, wind, and water amounts to 53.4 percent of the whole area. Only about 15 percent of the erosion was the result of run-off. This land needs a heavy cover of strong grass, and trees where trees will grow.

AN INCH OF WATER

On lands adapted to crops, good farmers have proved that 18 inches of rainfall, the rough yearly average for the Plains, is sufficient moisture for a permanent agriculture, if properly utilized. If 1 inch of water runs off an acre of land, a tank wagon holding a ton would have to make 113 trips to bring the water back. Vegetation provides a protective mantle against wind and sun and makes it possible for the land to absorb a greater amount of rainfall when it comes.

DR. BENNETT APPOINTED

The President has appointed Dr. H. H. Bennett, Chief of the Service, as a member of a committee to confer with farm organization leaders and others regarding the development of a crop insurance program.



FARM WOODLAND RETURNS[1]

By E. V. Jotter[2]

The present consideration is a discussion of dollars-and-cents return to the individual landowner, rather than of the more intangible public values. It is true that today there is general appreciation of the efficacy of forest cover for maintenance of desirable soil and moisture conditions. The relation of 185,000,000 acres of farm woodland to surface and underground waters, and in turn to domestic water supplies, to irrigation, to transportation, and to power is conceded. The biological influences of forest wildlife such as the activities of soil microorganisms in their effect upon soil and moisture, and of woodland bird dwellers, especially their control of harmful insects, are recognized. The contributions of woodlands to recreation through the satisfaction of social and esthetic ideals, to pleasant farm surroundings, and to balanced land-use, are stressed in these days of lengthened leisure. They are all appreciated, but these are the public benefits. Except in a very general sense, they are not profits recognized by the individual when he considers his business. When the farmer asks, "What will I get from the farm woods?" he is none the less a patriotic citizen.

Cash from Wood Lots

To farmers in many parts of the United States the cash received from wood lots within the past few years represented a large portion of their entire cash income; often this income was what made possible a continued though inadequate existence on submarginal farm crop land. It was the extra cash that helped them "get by." As has long been the case in European countries, woodland returns in the United States are becoming of real economic significance. Almost $63,000,000, exceeded in cash income by only eight agricultural crops, came to farmers from their wood lots during the period of relatively low prices in 1934. When to this is added the value of woodland products used on the farms, the sizable figure of $116,000,000 is reached.

[1] This is the fourth article in a series.

[2] Senior forester, Woodland Section, Soil Conservation Service.

What are some of the records of individual farm returns? Here are a few examples:

A farmer in Muskingum County, Ohio, so LeRoy Frontz of the Soil Conservation Service reports, bought a farm including one building only, for which in 1918 he paid $1,500. On this farm, part hillside and part bottom land, past owners had starved out.

The present owner exercised good management in his use of the farm woods. He hired a portable sawmill and cut sufficient lumber to build a barn, a shed, a hog pen, and a chicken house. The remainder of his lumber was disposed of at a profit of $2,000, which more than paid his original investment in the farm.

Now he still has a woods with some merchantable timber. Other areas have young growth, which would have been true of the entire stand had he kept stock out of it.

They Burned Wood

In our own Service, John Fry, forester on the Coon Creek erosion-control project in Wisconsin, made a woodland-products survey on 118 farms within the area. He found the average farm woods produced in the winter of 1934–35, 11.3 cords of fuel wood worth $4 per cord, 649 board feet of lumber at $25 per thousand, 41 railway ties worth 35 cents each, and 259 posts valued at 10 cents each. The survey showed that the average farm included in the study produced in 1 year woodland products valued at $101.67, of which $87.32 was the value of products utilized on the farm. The fuel wood used on the average farm was equivalent in heating value to 9½ tons of anthracite coal. These woodland products, had they been purchased in the open market, would have cost the farmer $228.02 annually. Hence, these farmers saved $140.70 per year in actual cash by owning and utilizing productive woodland property.

The wages for services accruing to the farmer, where he uses his own labor or that of employees whose time might not otherwise be profitably employed, are important in this farm economic program. In view of this, it is curious that there are so few examples of profitably managed woods. Not only is there a general failure to

Two barns, a shed, a poultry house, 2,000 gallons of maple sirup, all the fuel wood used between 1910 and 1933, came from the 10-acre farm woods of Glenn Ingram. In addition, 23,500 board feet of lumber was sold and materials furnished for farm repairs. Present value of woods, $2,500.

tend woods, as is done with other farm crops, but fire and stock continue in many areas further to destroy the trees, the brush, and the woodland soil.

The New Outlook

Today it is gratifying to note that along with the development of a program to control soil and moisture, to institute better land use, to provide more farm revenue, there is increased recognition of the farm woodland. Some States and neighborhoods have made marked advance in the development of the program. The efforts of Federal, State, and private foresters, of a few large wood growers and users, and of farmers, singly and in organizations, are beginning to bear fruit.

In this program of woodland development the project manager and his technical aides, especially the forester, have unusual opportunities and responsibilities. Woodlands are recognized as a part of the farm program of farm use and returns. Farmers need firewood and fence posts, flue wood for tobacco curing, tomato or grape stakes, repair parts for a wagon or sled, rustic furniture, an arbor. It is part of the job to show the farmer when it is better farm economy to get and fashion the material from his own wood lot than it is to buy it.

That the farm woodland is destined to become an increasingly important factor in the control of erosion and the rehabilitation of worn-out soils is a generally recognized fact. Not so universally established, however, are the superior competitive advantages which, as a producer, the farmer possesses in supplying community lumber needs. The farmer, through his own activities and the help he can get, especially because the work may be odd-time labor, is in a superior position with respect to labor cost as compared with the owner of extensive timber holdings. Fire control within the agricultural area is relatively simple and obtainable at low cost.

The farmer can quickly sell or refrain from selling, and all his operations possess the advantage of quick response to current market trends. The farmer need not cut when there is a low market; he does not have to operate the woods to carry on his business.

In the farm woods there is a minimum of waste; where utilization of small lengths is possible, and top limbs or other unmerchantable saw timber can be sold or used as firewood. Such operations, because under direct supervision and personal interest of the owner, facilitate the betterment of the property, assuming that the farmer knows how to go about the work.

Certain parts of the United States have peculiar local advantages in supplying woodland products. Proximity to a pulp mill, opportunity to grow pulpwood at low costs, a good nearby market for furniture wood, for mining, timbers for summer cabins, for decorative material, for basket manufacture—the list could be multiplied.

Farm Land for Wood Crops

To the question as to just how much can be grown per acre per year there can be a general answer only. As well ask how many bushels of corn or wheat can be grown per acre, or how much forage can be produced. There are sites and sites; and, also, there are submarginal timber areas as well as submarginal annual crop areas. The forester can generally estimate returns expected; give him an opportunity and his figures as to future yields will check as closely as those of the other specialists.

The use of part of the farm for wood crops will be one of the features of a new agriculture. Foresters can help in bringing it about. Under the advice of competent and experienced technicians materially higher returns may be obtained.

THE INSPIRING STORY OF GOLDEN GATE PARK

(Continued from page 73)

Within the shelter furnished by these plants were gradually developed lawns and flower beds, nooks and walks, lakes and waterfalls, all embowered in masses of flowering shrubs and trees, the whole constituting a masterpiece of the landscape artist. The many thousands of plant species tried in the course of this horticultural experiment were of course not all equally successful, but the majority did survive and today serve to make Golden Gate Park a botanical garden in fact, if not in name.

Of recent years the work of plant introduction is being pursued more systematically, particular attention being given to plants native to regions having a climate similar to that of California. Several floral provinces having a like amount of rainfall, a rainless season of about the same duration, and a similar mini-

mum temperature in winter, have been especially fruitful in yielding novel plants for the park collection.

Australia, especially western Australia, has perhaps contributed more than the rest of the world combined, including many interesting and beautiful proteads, bottlebrushes, acacias, etc. New Zealand, if somewhat more humid, has yielded a nearly equal number of useful and showy plants, many of which are a legacy from the 1915 Exposition. South Africa's special contributions are the many kinds of heathers, some of which are sent by the carload to Eastern markets for cut flowers from the Bay region. Chile, too, has furnished numerous ornamental items. The so-called Mediterranean region has contributed much of value, as Cistus, Cytisus, lavender, etc., most of which have the merit of greater frost resistance than plants from the Southern Hemisphere.

In recent years a great many novel plants have been introduced from China and adjacent regions, among which the various species of rhododendrons must rank first. The various species and hybrids of rhododendrons easily constitute the horticultural highlight of the park season, and during April and May many plant lovers make pilgrimage, often from far away, to see the park's rhododendrons in flower. Numbering over 200 named varieties and nearly as many wild species, the park's collection of rhododendrons must be counted as one of the country's finest. An even more exotic impression is created by the park's fine groups of tree ferns. To see these giants of the moist tropics thrive like this in what originally was a sandy desert is a surprise indeed and an accomplishment of which one may well be proud.

In the near future an even more intensive development of this botanical side of the park is contemplated, with the fruition of plans for an arboretum, financed by a private bequest.

Space is lacking to tell of the many recreational features now sheltered here. The creation of Golden Gate Park is undoubtedly an outstanding example of successful soil conservation and reclamation.

SEEDING NATIVE GRASS IN CONTOUR FURROWS

By Wayne Austin [1]

With hundreds of miles of pasture terraces and contour furrows to be seeded on Colorado projects last spring, there was need for some type of hand-seeder capable of handling native grass-seed mixtures without clogging.

The common types of machine broadcasters clogged badly and failed to place the seed in the furrow. Broadcasting by hand was found to be very slow and unsatisfactory. The maximum possible by this method was 7 miles of furrow per day, and the seed was unevenly distributed. Invariably, more seed was used than had been estimated. Finally, we met the problem satisfactorily by adopting to our purpose a standard make of crank duster.

Among the changes necessary for converting the machine are the following:

1. Remove the wire agitator in top of hopper and eccentric drive rod.
2. Remove wheel agitator and break off two opposite wings. Extend the other wings laterally by soldering an extension near the tip.
3. Cut an oval hole 4½ inches long in the bottom of spout directly underneath the grill.
4. Solder a 10-inch tongue just in front of top of fan opening which has been cut at the bottom of the spout.
5. Cut off about 4 inches of the tube that extends in front of the machine and place it on the lower end of a new piece of tubing that has been made to fit the opening below the grill. The old opening is then soldered shut.
6. File the openings of the grill to a large size so that coarse seed can drop through. The regulator will still be effective to handle small seed. The size of the openings on the grill will depend upon the rate of seeding and the type of mixture.

With this machine, we are able to seed from 12 to 14 miles of contour furrow per day with ease, and at the same time get an even distribution of seed. By using the extension tube and spreader, it is possible to seed on windy days, an important factor in windy eastern Colorado. The machine is equipped with a fan which propels the seed out of the tube, forcing it into cracks and crevices in the soil where it will have a favorable chance to germinate.

The following species of plants are being seeded in various mixtures on these projects: *Melilotus alba*, *Bromus inermis*, *Agropyron smithii*, *Sporobolus airoides*, *Sporobolus cryptandrus*, *Bouteloua gracilis*, *Stipa robusta*, *Stipa spartea*, *Stipa comata*, *Atriplex canescens* (*wings removed*), *Elymus canadensis*, *Calamovilfa longifolia*, *Oryzopsis hymenoides*, *Andropogon furcatus*, *Andropogon scoparius*, and *Sorghastrum nutans*.

[1] Assistant agronomist, Soil Conservation Service.

STONE TERRACES OF KENTUCKY

(Continued from page 65)

vigorous growth of sumac and briars. On one of the unterraced, badly gullied slopes half of the area has been retrieved and completely stabilized by black locusts.

Except for the two benches cleared for cultivation by the present farm operator, the terraced hillsides are abandoned. But although we have improved upon the system of tillage which once prevailed there, we may learn much from the pioneering done here. With up-to-date methods, we may build soil-saving devices with less expenditure of effort, but we will do well to construct terraces that defy time and the elements as successfully as those built on this monastery farm nearly a century ago.

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

THE DESIGN OF EXPERIMENTS. By R. A. Fisher. Edinburg. London. 1935

This new book by the author of Statistical Methods for Research Workers and The Genetical Theory of Natural Selection is designed to illustrate the principles which are common to all experimentation, by means of examples chosen for the simplicity by which these principles are brought out; to exhibit the principal designs which have been found successful in the field of agricultural experimentation; and to illustrate their applicability to other fields of work. Chapter headings include the following: An Historical Experiment on Growth Rate; An Agricultural Experiment in Randomised Blocks; The Latin Square; The Factoral Design in Experimentation; Confounding; The Increase of Precision by Concomitant Measurements; Statistical Control; The Generalization of Null Hypotheses; Fiducial Probability; The Measurement of Amount of Information in General.

THEODOR BRINKMANN'S ECONOMICS OF THE FARM BUSINESS. Translation from the German. 1935.

Representative of modern German ideas concerning problems of agricultural economics, especially the problems of farm management.

Contains a general consideration of the types of farming; the levels of intensity in agricultural production and the orientation of its location; systems of farming or the orientation of the locations of the lines of production.

HANDBOOK OF NORTHWEST FLOWERING PLANTS. By Helen M. Gilkey. 1936.

The boundaries of the area covered in this handbook include roughly those of the rather natural floristic unit from the summit of the Cascades to the coast line of Washington and Oregon, as far south as the Umpqua Divide or about the southern limit of Lane County, Oreg. Analytical key, Glossary, Index.

SOIL SCIENCE, ITS PRINCIPLES AND PRACTICE. By W. W. Weir. Philadelphia. 1936.

Dr. Weir presents a new text on the study of soils and their classifications, soil fertility, and agricultural practices. Fairly extensive treatment is given the subjects of chemical nature and microbial populations of soils.

GAME MANAGEMENT. By Aldo Leopold. New York and London. 1936.

This book explains the possibilities of coordination between science and use in the field of conservation by game management. The subject matter is assembled by means of the productivity factors, i. e., the decimating factors (hunting, predators, starvation, diseases and parasites, accidents) on the one hand, and the welfare factors (food supply, water supply, coverts, special factors) on the other, the object being, apparently, to portray the mechanism which produces all species of game for all particular species, or the managing of particular lands. Special treatment is given the subject of game populations, with figures and charts on flight limits of bobwhite, grouse, partridge, pheasant, etc.; comparative mobility of game birds and animals; sex ratios; transplantation and domestication, as aids in determination of potential productivity. The game range is defined as a region habitable for a given species when it furnishes places suitable for it to feed, hide, rest, sleep, play, and breed, all within the reach of its coursing radius; and game management deals with offsetting deficiencies in any or all of these essentials and in keeping range types—farm game, forest and range game, wilderness game, migratory game—in balance.

The book contains sections on predator control, refuges, control of food and water, cover, control of disease, and accidents, and attempts to rationalize and classify the multitude of factors involved in game surveys and control management. A chapter with the title "Miscellaneous techniques" contains discussions on practical subjects such as artificial propagation, nesting studies, game maps and range tallies, game surveys. The author closes his book with a discussion of game administration and an outline of game as a profession, with some helpful information as to training and qualifications for game experts.

Appendix contains more than 400 references, with asterisked items recommended to the student of game as general reading; glossary of terms used in game management; breeding potential tables; index.

MAN'S INFLUENCE ON THE EARTH. By R. L. Sherlock. London.

This little book out of England tells a story of man's digging into and scratching over the surface of the earth: Interference with the flow of water, causing denudation; destruction of igneous rocks of deep-seated origin and making other rocks more to his liking; alterations of sea coasts so that his ships may anchor where he wills and he may build a city on so-called reclaimed land, the making of a desert where nature intended a forest or a wide plain with tall grass, and thereby modifying climate. Although the author limits fact and figure to Great Britain as a definite area, his message is none the less applicable to all other parts of the world where civilization with its iron and steel, its huge cities, its agricultural regions where the soil is worked forcefully and fiercely to the very bed rocks, and its precious gems, marches steadily onward through the centuries.

ELEMENTARY PLANE SURVEYING, TEXT AND MANUAL. By Raymond E. Davis. New York and London. 1936.

Treatise designed for students in architecture, forestry, and electrical and mechanical engineering. Contains map drafting; methods of plotting; calculation of areas of land; topographic mapping; the plane table; topographic surveying; route surveying; land surveying; determination of latitude and azimuth.

Field and office problems. Tables. Index.

U. S. GOVERNMENT PRINTING OFFICE: 1936

RECENT PUBLICATIONS ON CONSERVATION AND RELATED SUBJECTS

Compiled by Etta G. Rogers

(Field offices should submit requests on form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue)

Office of Information, United States Department of Agriculture

Blue Grama Grass for Erosion Control and Range Reseeding in the Great Plains, and a Method of Obtaining Seed in Large Lots. Circular 402. July 1936.

Choice of Crops for Saline Land. Circular 404. July 1936.

Cover Crops for Soil Conservation. Farmers' Bulletin 1758. July 1936.

Food Plants of the North American Indians. Miscellaneous Publication 237. July 1936.

Timber Growing and Logging Practice in Ponderosa Pine in the Northwest. Technical Bulletin 511. June 1936.

Silting of Reservoirs.[1] Technical Bulletin 524. July 1936.

Agricultural Experiment Stations

A Basis for Selection of Species for Reforestation in the Central Hardwood Region. Station Note 29. Central States Forest Experiment Station, Columbus Ohio. March 1936.

Cloquet Forest: A Demonstration of Practical Forestry in Northern Minnesota. Technical Bulletin 112. Agricultural Experiment Station, University Farm, St. Paul, Minn. January 1936.

Cropping Systems in Relation to Erosion Control. Bulletin 366. Agricultural Experiment Station, Columbia, Mo. July 1936.

Economic Study of Land Utilization in Broome County, N. Y. Bulletin 642. Cornell University Agricultural Experiment Station, Ithaca, N. Y. March 1936.

Factors Determining the Type-of-Farming Areas in Nebraska. Bulletin 299. Agricultural Experiment Station, Lincoln, Nebr. 1936.

Farm Irrigation Pumping Plants. Bulletin 237. Agricultural Experiment Station, State College, New Mexico. 1936.

Growing Good Crops of Oats in Missouri. Bulletin 359. Agricultural Experiment Station, Columbia, Mo. January 1936.

Ladino Clover for Western Oregon. Station Circular 117. Agricultural Experiment Station, Corvallis, Oreg. May 1936.

Lespedeza in Georgia. Circular 263. Extension Service, University of Georgia, Athens, Ga. February 1936.

Montana Land Ownership: An Analysis of the Ownership Pattern and Its Significance in Land Use Planning. Bulletin 322. Agricultural Experiment Station, Bozeman, Mont. June 1936.

Northern Bob-White's Winter Territory. Research Bulletin 201. Agricultural Experiment Station, Ames, Iowa. June 1936.

Planting of Food Patches for Wild Life. Game Management Circular 1. Game Division, Michigan Department of Conservation, Lansing, Mich. Revised April 1936.

Relative Efficiency of Roots and Tops of Plants in Protecting the Soil from Erosion. Bulletin 12. Conservation Department, Conservation and Survey Division, University of Nebraska, Lincoln, Nebr. January 1936.

Renovating Blue Grass Pastures. Circular 277. Extension Service, College of Agriculture, Madison, Wis. January 1936.

Results of Erosion. Agricultural Education, Volume 12, Nos. 6-9. Department of Agricultural Education, Clemson Agricultural College, Clemson, S. C. February, March, April, and May 1936.

Soil Changes Resulting from Nitrogenous Fertilization. Bulletin 384. Agricultural Experiment Station, New Haven, Conn. June 1936.

Soil Erosion in Iowa. Special Report 2. Soils Subsection, Agricultural Experiment Station, Ames, Iowa. April 1936.

Soil Erosion in New York. Bulletin 347. State College of Agriculture, Cornell University, Ithaca, N. Y. April 1936.

[1] Free distribution of U. S. D. A. Technical Bulletins is extremely limited. They are intended primarily for scientific workers and subject-matter specialists.

TREES and SHRUBS SCS to CHECK EROSION

250,000,000

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SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

Upstream Engineering Featured in This Issue

NOVEMBER 1936

CONTENTS

Cover design suggested by photograph

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WELLINGTON BRINK — EDITOR

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

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NOVEMBER • 1936

ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

Dr. H. H. Bennett, at his desk, receives his field administrators. Standing, left to right, are R. E. Uhland, Region 5; T. S. Buie, Region 2; Dr. W. C. Lowdermilk, Associate Chief; N. E. Winters, Region 7; H. H. Finnell, Region 6; H. G. Calkins, Region 8; J. S. Cutler, Region 3; H. E. Reddick, Region 10; W. A. Rockie, Region 11; L. P. Merrill, Region 4; A. L. Patrick, Region 1. H. J. Clemmer, Region 9, not in picture.

REGIONAL CONSERVATORS TAKE THEIR PROBLEMS TO WASHINGTON CONFERENCE

Conservators of the 11 regions met for the second time this year in Washington, September 24–28. With exactly 7 busy months intervening since the earlier and initial, conference, the field executives devoted themselves to perfecting administrative procedures, adjusting perspectives, and planning for the future.

Dr. H. H. Bennett, chief of the Service, sounded the keynote when he urged teamwork within the organization and cooperation with other agencies. He emphasized the duty of thinking in terms of service to the Nation as a whole.

In deference to problems arising from drought and other conditions peculiar to the region, 1 day's sessions were given over entirely to the West and Southwest.

All principal administrative officers of the Service, together with many members of their staffs, participated in the informal discussions around the long council table.

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D. S. Myer, Chief of the Division of Cooperative Relations and Planning, pointed out the necessity of establishing operation areas on the basis of a more definite formula or plan than has been in use for present demonstration areas. He looked ahead to the inclusion of additional watersheds in future operations. The standard State soil conservation districts law, he explained, offers a convenient model for legislation which will enable Federal Government, States, counties, districts, and communities to develop plans and assume certain responsibilities in the cause of soil conservation. It is expected that needed legislation will differ somewhat in the several States where agriculture's problems are dissimilar. Mr. Myer hopes to speed up the working arrangements with the several States, and depends largely upon the State coordinators to accomplish this end. The first step, in his opinion, is a reading and discussion of the proposed act, followed by the taking of an inventory of the situation in each State and by securing definite suggestions and criticism which will help perfect plans.

"I hope the time will never come when we shall draw a distinct line between operations and research", said Dr. A. G. McCall, acting head of the Division of Research. "We expect to get from you men on the actual firing line many suggestions as to studies, and it is my earnest concern to see how we can best fit research into the needs of operations."

Using Data at Hand

Dr. W. C. Lowdermilk, associate chief of the Service, who presided at the research session, stated that usable information has been accruing through the years in other bureaus, in the Office of Experiment Stations, and in the State experiment stations. He directed attention to the plan of cooperation with State institutions, originating at a meeting in Chicago in May with 22 directors of State experiment stations present. As a result of this conference, an amended memorandum of understanding was drawn up and submitted as a basis of agreement with State agricultural experiment stations. Forty-five such memoranda have already been submitted, signed, and approved by experiment station directors and the Secretary of Agriculture.

In discussing the functions of research, Dr. Lowdermilk stated that it should, first of all, serve operations. The results of our studies should constitute the basis for our work, he said. He noted that a principal reason for rapid progress made thus far is to be found in the research experience of many operations men, which enables them to interpret and adapt the findings of experimentation. He favored the development of annual meetings at erosion experiment stations, and saw an opportunity for research to be a mentor to the Service as a whole. Finally, he pointed to research as a means of foreseeing agricultural needs and preparing the way for a permanent agriculture.

In such research, State coordinators and project managers are expected to have an important share. An exploratory survey of research already accomplished is under way, which is expected to yield (1) recommendations for discarding control methods regarded as ineffectual, (2) recommendations for continuing measures which have proved their worth, and (3) questions on which information is badly needed and on which may be developed research programs for the States.

The Work Spreads

C. B. Manifold, Chief of the Division of Conservation Operations, reported that a recent survey made to determine the voluntary acceptance of our program on lands not under agreement indicates that soil-conserving practices have been adopted on as much land outside the demonstration and camp areas as that on which agreements have been signed within project and camp areas. He pointed out that this wide spread of practices was due to the care in the selection of project areas, the development of working plans, the sound application of approved soil and water conservation practices and the cooperation of the extension service and other agencies in bringing these practices to the attention of the public.

He advocated a policy of rigidity in field administration, allowing for such modification as may be dictated by special conditions.

Mr. Manifold directed attention to the systematized plan of field inspections by the Washington technical staff. He indicated that from time to time members of the field staff will be brought into the Washington office to review operation procedure and assist in field inspections.

He discussed the need for maintaining cost and production records of nursery stock as well as accurately maintaining the general cost records.

Throughout the conference, the disposition was to look around and to look ahead: to orient, coordinate and cooperate in current activities, and to plan and prepare a permanent program.

FLOOD MENACE AND EROSION PROBLEM CHALLENGE SCIENTISTS OF MANY FIELDS

Information Consolidated at Noteworthy Upstream Engineering Conference

Following closely upon the adjournment of the Third World Power Conference and terminating in the epochal Young Men's Conference On Behalf of a Continent, the Upstream Engineering Conference held in Washington, D. C., September 22–23, brought to common focus the viewpoints of the sciences directly concerned with soil- and water-conservation.

For the first time in the history of the United States, outstanding specialists in soils, erosion, geology, agronomy, forestry, horticulture, wildlife, hydraulics and other branches of engineering, came together to compare notes on how to prevent floods and to save wasting farm lands.

Tuesday Morning

Dr. Robert A. Millikan, chairman of the executive council of the California Institute of Technology, sounded the gavel for the opening session on Tuesday

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UPSTREAM ENGINEERING CONFERENCE

SEPTEMBER 22 AND 23, 1936

ORGANIZING COMMITTEE

Hugh H. Bennett, Chief of Soil Conservation Service
Morris L. Cooke, Administrator of Rural Electrification Administration
F. A. Silcox, Chief of the Forest Service

AUTHORIZATION

June 16, 1936.

Hon. Henry A. Wallace,
Secretary of Agriculture,
Washington, D. C.

My dear Secretary Wallace:

Upstream engineering will have a major part in efforts to save the land and control floods, and for that reason it offers a broad field of opportunity for the engineering profession. I am therefore in hearty accord with your suggestion that there be held an open conference on the subject in early fall. The date might well be in proximity to that of the Third World Power Conference in September, in the hope that some of the distinguished foreign engineers attending the latter may be interested also in contributing to the proposed conference.

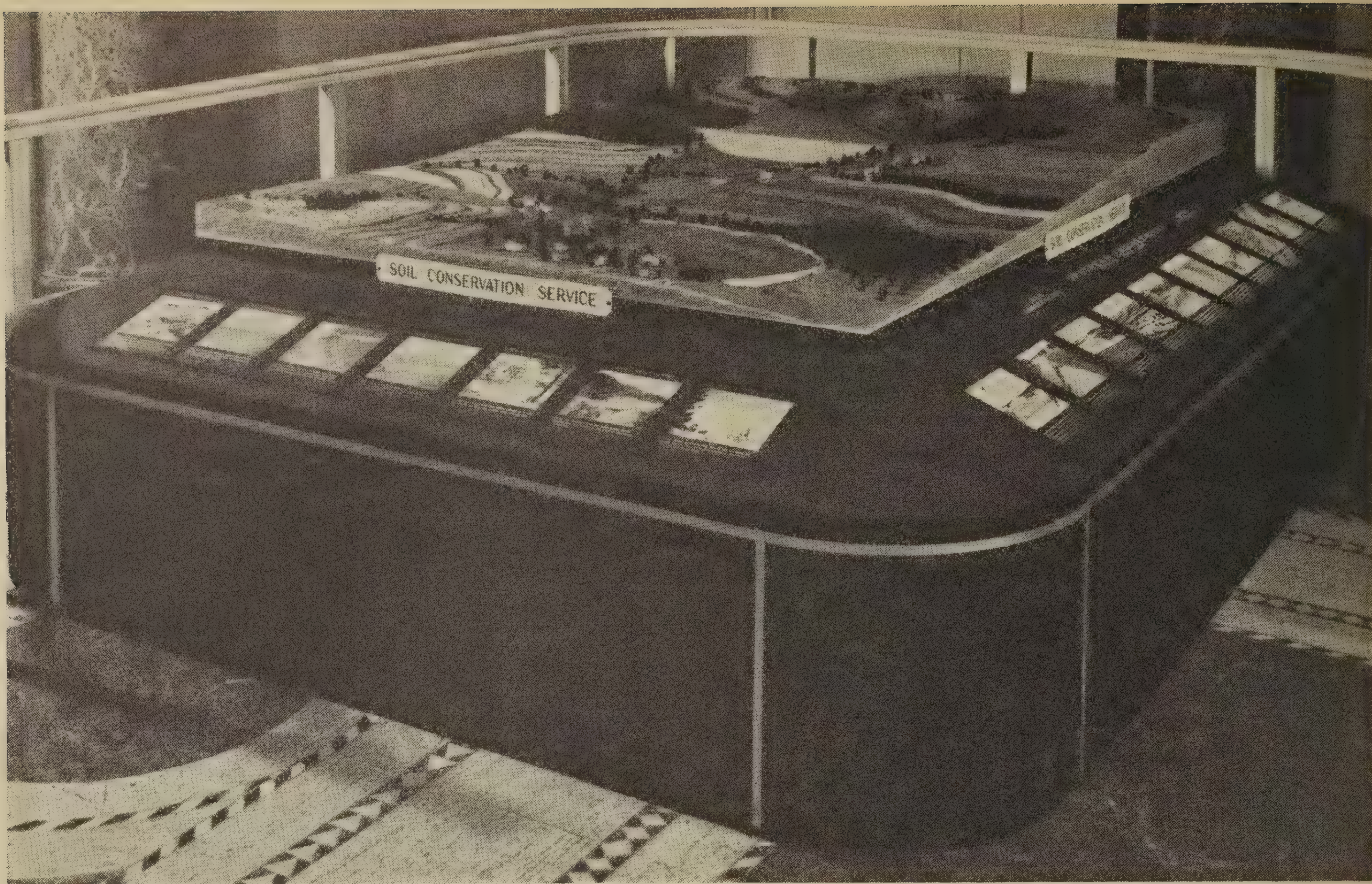
There are indications that a substantial body of technical information on the control of little waters is now available in the scattered records of American experience—Federal, State, and professional. The urgent problem is to bring these data together in a coordinate body of engineering knowledge so that public officials and engineers may have a more definite picture of the upstream engineering as an important field of public and professional activity.

There is a wealth of experience and data as to downstream engineering and works required for navigation, power development, and flood control—levees, large dams, great reservoirs, and channel improvements on major streams. But necessary as these are for the safeguarding of those who live in areas subject to destructive floods and of property located therein, it must be remembered that downstream waters originate largely in upstream areas. The objects of upstream engineering are, through forestry and land management, to keep water out of our streams, to control its action once in the stream and generally to retard the journey of the raindrop to the sea. Thus the crests of downstream floods are lowered.

In accordance with your further suggestion I am appointing as a committee to organize and promote such a conference or institute: Hugh H. Bennett, Chief of the Soil Conservation Service, Department of Agriculture; Morris L. Cooke, Administrator of Rural Electrification Administration; and F. A. Silcox, Chief of the Forest Service, Department of Agriculture.

Very sincerely yours,

Franklin D. Roosevelt.



General exhibit of the Soil Conservation Service, which attracted widespread interest and comment from members of the Upstream Engineering Conference.

morning, September 22, and also filled the role of toastmaster at the dinner session that evening.

The first meeting featured papers by Dean Thorndike Saville, of the College of Engineering, New York University, and President Isaiah Bowman, of Johns Hopkins University.

Dean Saville, leading a discussion of Basic Principles of Water Behavior, termed the common view that rainfall is a result of evaporation from the ocean a misconception. He urged a scientific program of coordinated research in headwater control and land- and water-conservation. He declared that less than 30 percent of the rainfall of the United States comes from oceans, as compared with 70 percent by evaporation from the land.

Hydrologic Cycle Cited

Proof of this, his paper pointed out, is found in the study of the hydrologic cycle. Careful measurements, he said, show that the water level of the ocean is practically constant; therefore, that part of the rainfall which results from ocean evaporation cannot exceed the amount of water which flows back into the ocean. While run-off studies are woefully incomplete and rainfall estimates suffer from the same handicap, nevertheless they indicate clearly that much more water falls on the land than runs off. The remainder comes from land evaporation and from transpiration of plants.

Dean Saville suggested the setting up of thousands of transpiration and infiltration measurement stations. He warned, however, that data alone will not solve the problems of up-stream engineering and recommended a carefully conceived program covering all aspects of the problem and commanding the efforts of various governmental and nongovernmental agencies.

Cumulative Drainage

In a companion paper on The Influence of Vegetation on Land-Water Relationships, Dr. Bowman asserted that waste of water and its attendant evils have done more damage to the United States than war.

"We have been too long in the wild Indian stage, willing to scalp the land and leave it a red horror", he told his hearers.

Conservation of land and control of water must be carried out in three stages, Bowman said. First,

science must determine the nature and extent of the problem; second, management plans must be evolved from scientific plans; and finally, there must be cooperation between government and individuals in applying standardized practices.

"When the drought and dust storms come, we hear of prayers for rain by families or whole communities", Bowman said. "It would be far more sensible to pray for intelligence enough to take proper care of the soil and its cover when there is no drought. But steady, long-range work is apt to be neglected as soon as we think that the evil genii are on holiday. This is a bad business, for the conservation of land and water means also the conservation of people."

More Study Needed

Pleading for more extensive studies of long-range weather conditions, Bowman said: "We have hundreds of observers at rainfall stations gathering data for short-range weather predictions. But we have few sifters of the readings and recorded facts to get at the long-range meanings.

"The rain that affects a holiday or a shipment of perishables may seem important at the moment, but it is the effect upon vegetation and soils that in the long run determines whether people can live in an area or have perishables to ship or can afford a holiday."

Bowman declared that the long-range headwater problems of water and land cannot be solved without an understanding of the values and uses of watersheds as a whole. Upstream engineering, he concluded, is "fundamentally a social question with aesthetic, economic, political, and educational aspects."

Dr. Lowdermilk Speaks

Five-minute floor discussions at this session of the conference were by William Peterson, director of Extension Service, Utah State Agricultural College; LeRoy K. Sherman, consulting engineer, chairman of the Section of Hydrology, American Geophysical Union; Forrest Shreve, desert laboratories, Carnegie Institution, Tuscon, Ariz.; Carl O. Sauer, head of the department of geography, University of California, and W. C. Lowdermilk, associate chief of the Soil Conservation Service.

Dr. Lowdermilk spoke, in part, as follows:

"Dr. Bowman's paper is an important contribution to the literature on upstream engineering, involving the conservation of soil and water resources. The essential harmony of the complex of factors which make up land resources, including soil, vegetation, and water, has been appropriately emphasized. Moreover, the necessity of treating the resources of a drainage area as a whole—that is, as a unit—in the problems of upstream engineering, has been properly brought into clear relief.

"Dr. Bowman has laid his principal emphasis upon the influence of natural vegetation, such as forests and grass, on the regimen of streamflow and the conservation of soil. This leaves us the opportunity to call special attention in this discussion to the dramatic changes wrought in natural harmonies by clearing land of its native cover and the cultivation of such bared soils to necessary agricultural crops * * * .

"Surficial run-off from rains approximating an intensity of 2 inches in 1 hour was found to occur in the following order: From native forest, 2 percent; from grass land, 5 percent; from fields in close-growing grains, 25 percent, and from row crops such as corn and cotton, 50 percent. Run-off from fields in corn or cotton may be 25 fold that from forests under intense rains. Thus, these several conditions rank in reverse order as to rate of intake, namely, for forests 98 percent, for grain fields 75 percent, and for fields in row crops 50 percent. The most acute phase of the problem of land-water relationships in flood control and upstream engineering resides in the sloping lands cleared for cultivation.

Run-Off Differences

"The full import of these dramatic differences is arresting. It seems at first thought improbable in view of the absence of similar effects in the channels of major streams. The apparent lack of continuance of the dramatic differences in run-off in small areas to large streams has created confusion in the conclusions of many students of the problems of floods and streamflow. This point has been discussed more fully by me in other papers. In a general way, the expected run-off per square mile diminishes as the size of a drainage area increases. For example, run-off per square mile for certain areas in the Mississippi Valley will exceed 2,000 second-feet for a single square mile, whereas the run-off for the entire Mississippi drainage is approximately 1 second-foot per square mile. This wide difference in run-off from small and large areas is due principally to the relative size of areas contributing run-off; in small drainages the entire area may contribute to flood run-off, in large drainages only a fraction of the entire area will contribute to flood run-off.

The larger the drainage, the smaller will be the proportion of the area contributing to flood run-off. Thus measurements of run-off in major streams obscure the progressive trends in run-off characteristics of small areas. The behavior of major streams can be used neither as a measure nor as a criterion of the conditions of infiltration or absorption on small areas. The nature of processes at work within a drainage may be known chiefly by the responses on small areas, i. e., at the beginnings. Similarly, an estimate of the future condition of a landscape under agricultural uses must be inferred primarily from upstream phenomena. The downstream effects are resultants of a maze of interrelated factors which defy evaluation. For downstream flood control works must be designed on the basis of probabilities or combinations of factors."

As the discussion proceeded to the application of fundamental concepts in land management and engineering, the acting chief of the Forest Service, Earl H. Clapp, brought out the fact that floods on the Mississippi have increased greatly since the first white man saw the river in a major overflow in 1541.

"Natural factors favorable to absorption have been greatly reduced in many drainage basins of the United States as a result of exploitation of our natural resources", the speaker pointed out. "We have an accumulation of evidence showing the intimate relation between increases in floods and erosion and the increased depletion of forests and range cover."

He set forth a three-point program for watershed control:

1. Reestablish and maintain a balance between vegetation, soil, and water.

2. Devise a method of land-planning that will release for the common good the other resources and services of watersheds insofar as they will not interfere with soil and water conservation.

3. Fullest economic use of engineering devices, both temporary ones to make possible the restoration of vegetation and permanent ones to supply controls which vegetation alone cannot give.

Mr. Clapp's paper was augmented by brief remarks from Clarence F. Korstian, director of Duke Forest, Duke University; Clarence L. Forsling, director of the Appalachian Forest Experiment Station, and Leigh J. Young of the School of Forestry and Conservation, University of Michigan.

Highlighting consideration of the management and use of agricultural lands was a paper by Dr. H. H. Bennett, Chief of the Soil Conservation Service. Dr. Bennett told the Conference that in his opinion the era of land exploitation and extravagant waste of water resources in this country is nearing its end.

Paper by Dr. Bennett

"We are beginning soberly to realize", Dr. Bennett declared, "that our traditional American indifference or unsympathetic attitude toward the conservation of natural resources is leading us into a complexity of economic difficulties—good soil and needed water wasted, dust storms, stream channels and reservoirs glutted with silt, record floods. We are learning that we have been a prodigal nation and that the magnificent natural heritage with which we began our career as a nation is not inexhaustible. In a new sense we are becoming land and water conscious.

"That new conservation machines are being manufactured in increasing quantity and variety—machines for conserving soil and water, such as terracers, subsoilers, and basin listers—is but a sign of the times, as I see it. I am convinced the movement cannot be arrested.

"In the Soil Conservation Act of 1935 Congress for the first time recognized accelerated erosion as a national menace and declared it to be the policy of Congress 'to provide permanently for the control and prevention of soil erosion and thereby to preserve natural resources.' Out of this forthright declaration evolved the Federal-State program of soil and water conservation now in progress through the coordinated land-protection program of the Soil Conservation Service over far-flung parts of the country.

"And the Flood Control Act of 1936 is of historic significance, also; for it is the first time, to my knowledge, that the part of the agriculturist in flood control has been officially and specifically recognized by Congress.

Silt deposit on original flood plain soil.

"In what I have said to this Conference—to you who have joined in this effort to bring together the best ideas and plans of our several specialized fields in friendly cooperation for developing a far-reaching, comprehensive program to the upper limits of watersheds—it will be thoroughly understood, I believe, that agriculture is not proposing a substitute for flood-water fortification downstream. I am convinced you appreciate that what the agricultural specialists are offering is what, in all good faith, they consider upstream reinforcements to downstream operations by conservation work on the land where floods begin and where silt loads are picked up. The immediate task ahead is to agree upon a simple procedure of cooperation and coordination, whereby the engineer and the agriculturist will be working and thinking and planning along the same line, and for a common purpose. When such a procedure is mutually understood and cooperatively put into effect, I am confident that we shall then be definitely on the way to success.

"Furthermore, I believe that the way has been marked, the pattern cut. Those who have the vision and the will to move forward in unison—downstream along our major waterways, upstream along the little waters, and out into the fields and pastures and woodlots, on the ranges and far into the mountains—will find a supporting hand in the farthermost corners of this progressive Nation.

"We must ally our forces to defend ourselves against floods and soil erosion, for these are also allies, but allies in destruction.

"My thesis is that the proper treatment and management of land—soil husbandry, if you please—is more instrumental than any other individual factor in determining the rate and volume of rainfall run-off and the consequent loss of soil from given agricultural areas. I believe sufficient information is now available to say with confidence that the frequency of moderate floods can be reduced and the crests of abnormal floods definitely lowered in many trunk streams by proper land treatment, which means efficient land protection, over the contributory watersheds. Downstream engineering work must continue to carry a very large share of this responsibility; but it may reasonably expect assistance upstream where efficient adaptable measures of soil and water control are applied to the ultimate limits of our little waters. Already 1,397,000 check dams and 178,000 permanent dams in gullies and small drainages have been constructed; and, to date, a vast amount of protective work has been carried out on the lands of some 35,000 cooperating farmers, as well as on many millions of acres of public lands."

Conceding that there have always been floods, Dr. Bennett declared that a study of alluvial deposits reveals that the sediment laid down in the past 50 to 75 years was brought down by more violently flowing waters than those of former times. The recent deposits are coarser and less uniform than the earlier layers, showing that widespread stripping of natural cover followed by cultivation resulted in more violently flowing water which means high floods.

Dr. Bennett said he envisages upstream control as a reinforcement to downstream operations and not as a substitute. With approximately 100,000,000 acres of crop land already destroyed or seriously damaged and another 100,000,000 acres still in cultivation but stripped of most of its top soil, erosion looms as a danger to the well-being of the Nation, Dr. Bennett pointed out.

Dr. Bennett cited the South Palouse watershed in the State of Washington as an example of successful soil- and water-conservation practices. Previously the stream alternated from a raging torrent to a dry bed. During the past 2 years it has flowed steadily in spite of the lowest rainfall on record. Trout have returned to the stream for the first time in more than two decades and general stream conditions are approaching those of 35 years ago before the advance of agriculture.

Referring to research, he said: "Much * * * remains to be done in this field; we do not, by any means, know all that we should know about fundamental principles involved with either water or wind erosion, nor have we acquired all the information needed in the way of practical measures for control and prevention. Our investigations thus far have shown, for example, that sheets of water flowing across certain peculiar soils involve loading and unloading behaviors with respect to silt, as well as peculiarities of abrasive planation and incision, that are almost entirely outside present understanding. For example, we know little about the hydraulic principles under which as much soil material is removed from an area of narrow width, on certain types of land, as from one of much greater width. As a matter of fact, very little attention has been devoted to this abstruse phase of hydraulics, as well as numerous other processes in this field, which involves, perhaps, as many variables and complexities as any branch of dynamics. We have not even initiated investigations in relation to

differential erosion, and we have scarcely touched the field of subsoil tillage, especially in its adaptation to particular subsurface structures and consistencies as a practical means of stimulating water conservation by infiltration.

"* * * we have acquired far too little information with respect to the amount of water that falls on the land. The astounding peak of the disastrous 1935 flood in the Republican River is an illustration in point. That peak climbed far above any curves likely to have been projected on the basis of rain gage records within the watershed of that stream or of neighboring streams. Even the precipitation readings for the rain that brought on the disaster do not account for the prodigious volume of water that charged down the valley; somewhere between the established gages the rainfall must have attained intensities wholly out of line with any actual measurement."

Dr. Thornthwaite Participates

Casting further light on Dr. Bennett's reference to rainfall, Dr. C. W. Thornthwaite, head of climatic and physiographic investigations for the Soil Conservation Service, spoke informally as follows:

"In illustrating the deficiencies of essential data for the development of proper methods of upstream soil and water conservation, Dr. Bennett referred to a climatic project being operated by the Soil Conservation Service in western Oklahoma. In this survey precipitation records are obtained from 200 rain gages concentrated in 3 counties and spaced at an average distance of 3½ miles. From these records maps showing the fall in each 15-minute period and others showing the accumulated depth of precipitation are made. Over 800 such maps were required to chart the rainfall distribution for the month of May 1936. The maps of a rain which occurred in the late afternoon of May 1 are presented for the Conference on the chart in the Soil Conservation Service exhibit.

"The 10 maps on the left side of the chart show the amount of rain which fell in each 15-minute period between 4:45 p. m. and 7:15 p. m. In this series it is possible to trace the migration of the storm and the development and change of the centers of greatest intensity. The 10 maps at the right show the accumulation of precipitation from 7 a. m. until 7:15 p. m. During this period of time more than 3 billion 500 million cubic feet of water fell on the portion of the Cimarron watershed included in our project.

In a subsequent issue the magazine will carry excerpts from some of the other papers presented before the Conference. Complete proceedings of the Conference are being prepared or publication.

"The studies carried out on this project suggest an entirely new approach to the flood problem. We propose to study the characteristics of complete storms; determine their areal extent, their usual migration pattern, their intensity distribution, their total water contribution, and the pattern of the rate of fall. Statistical studies will determine the frequency distribution of rates of fall for storms having various size, shape, and migration characteristics. These facts can be applied directly to watersheds of known area, configuration, and cover to determine the probability of fall of rainfall of certain amounts and rates. From this the extent of flood hazard can readily be determined."

Other commentators from the floor included Noble Clark, assistant director Agricultural Experiment Station, University of Wisconsin; Samuel H. McCrory, chief, Bureau of Agricultural Engineering, United States Department of Agriculture; George E. Condra, dean of the conservation and survey division, University of Nebraska, and Robert P. Holdsworth, forestry department, Massachusetts State College.

Dinner Program

Addresses at the dinner included Big Waters and Little Waters, by Maj. Gen. Edward M. Markham, Chief of Engineers, War Department; The Human Value in Upstream Engineering, by Charles Harris Whitaker; Building Toward a Permanent Agriculture, by Jacob G. Lipman; and Control and Use of Little Waters in France by Inspector General Magnein, Administration of Waters and Forests, Paris, France.

Wednesday Morning

Immediate completion of the topographic map of the United States and drastic revision and early completion of the soil maps of the country were urged before the Wednesday morning session of the conference by Robert E. Horton, consulting hydraulic engineer of Voorheesville, N. Y.

In calling for a coordinated program of upstream control, Mr. Horton also urged the installation of more rainfall and run-off recording gages and the immediate publication of all available ground-water level records.

The speaker took up the scientific aspects of run-off in minute detail. Even the humble earthworm came in for scientific evaluation when Mr. Horton showed that the amount of water filtering into the soil is greatly influenced by earthworm holes and other perforations near the surface of the soil. Plowing up the land destroys the natural pores, he explained.

Mr. Horton's paper was briefly commented upon by Walter N. White, senior hydraulic engineer, Water Resources Branch, United States Geological Survey, and George Knapp, engineer for the water-conservation and flood-control committee of the Kansas State Board of Agriculture.

Dean Clyde Appears

George D. Clyde, dean of the School of Engineering, Utah State Agricultural College, in discussing Control and Use of Small Streams, said that no water escapes from the Bear River Valley into Great Salt Lake without first having generated power, supplied irrigation demands, and filled artificial basins for wild-fowl development. Bear River was described as "the most completely controlled and utilized stream in the United States." It irrigates 420,000 acres of land supporting 63,000 people, and generates 73,000 horse-power of electric energy.

Dean Clyde termed control of small streams to permit more efficient use of water and to prevent erosion and flood damages an urgent need throughout the United States. He favored control structures based on sound designs and rigid specifications with careful inspection upon completion of the work.

Dividing the country at the 100th meridian into two distinct problems he said the problem in the eastern half is disposal of water, while in the semiarid regions of the West conservation of water is the primary concern. Both demand control of flow, if maximum usefulness and protection is to be obtained. Control structures in the East serve to reduce flood crests; in the West they seek to retain the water for irrigation purposes.

Dean Clyde's paper was amplified from the floor by Edward R. Jones, chairman of the department of agricultural engineering, University of Wisconsin; and Abel Wolman, chairman of the Water Resources Committee, National Resources Committee.

Wednesday Afternoon

The final session of the Conference listened to The Comprehensive Engineering Point of View as set forth in papers by Sherman M. Woodward, chief water control planning engineer, Tennessee Valley Authority, and Ralph U. Blasingame, head of the agricultural engineering department, Pennsylvania State College.

Mr. Woodward cited records taken in Imperial Valley, Calif., where between 1 and 2 million acre-feet of water a year is passing into the air. Before the coming of irrigation some 30 years ago no such evaporation existed, he said. Yet there is no evidence that the climate has changed in the least. He declared that,

"Although Weather Bureau records show great variations in the amount of precipitation from year to year in all parts of the United States, authorities generally agree that there are in different regions cycles of wet years and cycles of dry years extending over varying periods of time, and that our records of precipitation are too brief to show any definite change in climate or that man's activities have had any effect on the amount and distribution of precipitation."

Many Fields Involved

Mr. Woodward spoke of the necessity of scrutinizing a wide range of scientific information before planning measures of control:

"The science of soil management occupies a borderline field touching, on one side, the physical sciences of hydrology, climatology, physiography, hydraulics, and agricultural engineering; on another side, the biological sciences relating to ecology and plant growth and production; on a third side, the sciences dealing with the economic and cultural factors involved in human occupation and use of the land. The program of the conference up to this point has been a sufficient demonstration of the complicated and involved nature of the many interrelations between these various sciences."

Final Word From Morris L. Cooke

A democratically chosen "moderator" for every major and minor watershed who would be without legal authority, yet represent the interests of the citizenry in the conservation of soil and water was suggested by Morris L. Cooke at the closing session.

"If we are to save our lands and make better use of our waters", Mr. Cooke said, "we must work out a national procedure which utilizes local autonomy as part of a coordinated national body politic." State compacts, State and regional planning boards, and authorities such as T. V. A. were cited as possible answers to the problem of coordination.

"Our battle against dust storms, droughts, floods, and especially soil erosion is being retarded by 'the disease of distance'", Mr. Cooke said. "What we need is that all citizens—north, south, east, and west—face the fact that soil erosion is going on over a large part of the cultivated area of our country, and that the variations are chiefly those of the tempo at which the destruction is being effected.

"No section of the country can be allowed to be ravished beyond a certain point without the rest of the country suffering", he warned. "The irrefutable fact is that within a relatively limited time, as the history of Nations goes, practically all the plowable lands will be ruined unless in the meantime we learn the technique of defense and apply it."

Mr. Cooke's message elicited discussion from the floor by Lt. Col. Glen E. Edgerton, Office of Chief of Engineers, War Department; Charles E. Holzer, president, Ohio Valley Conservation and Flood Control Congress, and Harlan H. Barrows, head of the department of geography, University of Chicago.

Much of the success of the Upstream Engineering Conference is attributed to the skill with which its sessions were directed from the rostrum. In addition to Dr. Millikan, presiding officers at the several sessions included Dr. Hugh P. Baker, president, Massachusetts State College; Frederick N. Feiker, executive secretary, American Engineering Council, and Frederic A. Delano, vice chairman, National Resources Committee.

THERE WAS NO CONFERENCE THEN

"If western land spoilers knew how eastern land skinners had skinned their land to death, they would not go on doing just the same thing. But they won't know, and, of course, won't do." . . . Solon Robinson wrote this warning on December 10, 1845.

See the book review, on page 108 of this issue

SERVICE SUFFERS LOSS THROUGH DEATH OF HENRY M. EAKIN

Henry M. Eakin, head of the Section of Sedimentation and Hydraulic Studies, Division of Research, died in Washington, D. C., October 20.

Mr. Eakin was born June 12, 1883. His undergraduate studies were pursued at Nebraska Wesleyan University and the University of Nebraska and followed by postgraduate work in geology and physiography at the University of Chicago.

From 1906 to 1918 he was with the Alaskan branch of the United States Geological Survey, after which he was engaged in the private practice of engineering in Seattle, Wash. In 1929 he was with the Dominion Explorers of Canada making geological investigations in the Canadian Northwest. From 1930 to 1933 he served as senior scientist for special investigations on sedimentation and river hydraulics under the Mississippi River Commission.

Since 1934 Mr Eakin had been with the Soil Conservation Service, first as specialist in sedimentation studies to organize a program of reservoir silting surveys, later as head of the section which embraces the field of downstream influences and effects of accelerated erosion and methods of control.

Mr. Eakin was an outstanding authority in his field and a writer much in demand. Intensely devoted to the cause of soil conservation, he was given to thinking far ahead of his generation. Shortly before his death he had the satisfaction of seeing fresh from the press his contribution, Silting of Reservoirs, issued by the Department of Agriculture as Technical Bulletin No. 524, which promises to stand as one of the most important publications of the Soil Conservation Service for many years. This bulletin is briefly reviewed on page 108 of this issue. Mr. Eakin was also a valued contributor to SOIL CONSERVATION.

A few of the many papers by Mr. Eakin follow:

The Influence of the Earth's Rotation upon the Lateral Erosion of Streams. Journal of Geology, Vol. 18, pp. 435–447, 1910.

Mineral Resources of the Yukon-Koyukuk Region, Alaska. U. S. G. S. Bull. 592, pp. 371–384, map, 1914.

River Engineering. (Encyclopedia Americana, 1920 and later Editions.)

Reservoir Silting Results from Preventable Erosion, Survey Shows. Soil Conservation Service, Soil Conservation, Vol. 1, No. 3, pp. 6–7, 1935.

The Twin Problem of Erosion and Flood-Control. Trans. Amer. Geophysical Union 17th Annual Meeting. pp. 436–439, 1936.

(With Glenn L. Fuller.) The Arrest and Prevention of Devastation by Floods. U. S. D. A. Soil Conservation Service, MP–12, 11 pp., 1936.

Meeting the Menace of Overflow Waters. Soil Conservation Service, Soil Conservation, Vol. 1, No. 6, pp. 5–6, 1936.

RESERVOIR SILTING IN THE NEW RIVER WATERSHED

By

Carl B. Brown

and

Farrell F. Barnes[1]

View upstream across Washington Mills Dam, Fries, Va., showing silt deposits within a few feet of crest level. Picture taken while reservoir being drained for double purpose of replacing flashboards and flushing sediment from 80-percent silted reservoir.

Investigations of erosion conditions on the New River watershed by measurements of silting in reservoirs have just been completed by a field party of the Section of Hydrodynamic Studies, Division of Research. A series of four reservoirs, 3, 6, 15, and 58 miles respectively, above Ivanhoe, Va., were surveyed to determine the amount and rate of storage depletion by silting. The results of the surveys also indicate, quantitatively, a minimum rate of soil removal to be expected from watersheds similar to that of the New River. A special feature of these investigations was a study of the effect of one or more reservoirs on the silting rate of other reservoirs downstream.

Watershed Conditions

An erosion survey by the Section of Conservation Surveys, Division of Operations, shows that approximately 78 percent of the New River watershed is either cut-over, pasture, or cultivated land, and that sheet erosion has been moderate to severe on all land which has not been protected by a woodland cover. The most severe sheet and gully erosion has occurred in the southern headwater part of the area, tributary to these reservoirs, where the soils were derived from schist and granite. The limestone soils in northerly areas, below the reservoirs, are not subject to severe gullying under present farming practices.

Location and Description

The Fields Dam—to begin at the upstream end of the series—is 4 miles northeast of Mouth of Wilson, Va. The original reservoir had a maximum depth of 8 feet, a length of 1.3 miles, and a storage capacity of 184 acre-feet. Washington Mills Reservoir, at Fries, Va., about 43 miles below Fields Reservoir, was originally 40 feet deep at the dam, with a length of 1.6 miles and a storage capacity of 2,954 acre-feet. Byllesby Reservoir, 9 miles downstream from Fries, had an original maximum depth of 52 feet, a length of 3.4 miles, and a storage capacity of 8,892 acre-feet. Buck Reservoir, 3 miles below Byllesby, was originally 20 feet deep at the dam, with a length of 1.1 miles and a storage capacity of 1,225 acre-feet. Washington Mills Dam was built in 1902, Byllesby and Buck in 1912, and Fields in 1930, so that their ages are approximately 33, 24, and 6 years, respectively. (See table.)

Character of Sediment

The sediment in these reservoirs consists of dark gray, very fine silt, mixed and interstratified with varying proportions of fine to coarse sand, and minor amounts of organic material. There is very little change in character from one reservoir to another, except in the relative proportions of silt and sand. In general, the deeper reservoirs contain a larger proportion of silt, but even in these the relatively strong currents, characteristic of narrow channel lakes, have swept large quantities of medium to fine sand virtually to the dam.

Results of Investigation

Original and present capacities and silt volumes were determined for each reservoir by special field methods, involving the preparat.on and comparison of contour maps of the original and present basins of Washington Mills and Byllesby Reservoirs, and direct measurements of silt thickness by silt-sampling spud and auger at Buck and Fields Reservoirs. The

[1] Mr. Brown is associate geologist and Mr. Barnes is junior engineer, Section of Hydrodynamic Studies, Division of Research, Soil Conservation Service.

(Continued on p. 106)

AGRONOMY HEAD TOURS PROJECTS AND REPORTS TO CHIEF

WELL, DR. BENNETT, I found that a good many of those New Jersey farmers are mulching their orchards. They're cutting broomsedge, hauling it, and spreading it on the ground so that it serves much the same purpose as a cover crop. They like the idea of Reed canary grass for seeding on wet lands, the crop to be cut and used between their peach and apple trees. They are planting their new trees on the contour, too; although some of them object to this in square fields because they can't get in as many trees as they want. Other farmers appreciate the value of protected soil at the cost of a few trees. The main point is, though, that they like to keep their orchards in sod or sod strips whenever possible. It was encouraging to me to find orchard grass, a shade-loving plant, growing under the trees, even though there is some trouble with curculio which lives over in such vegetation.

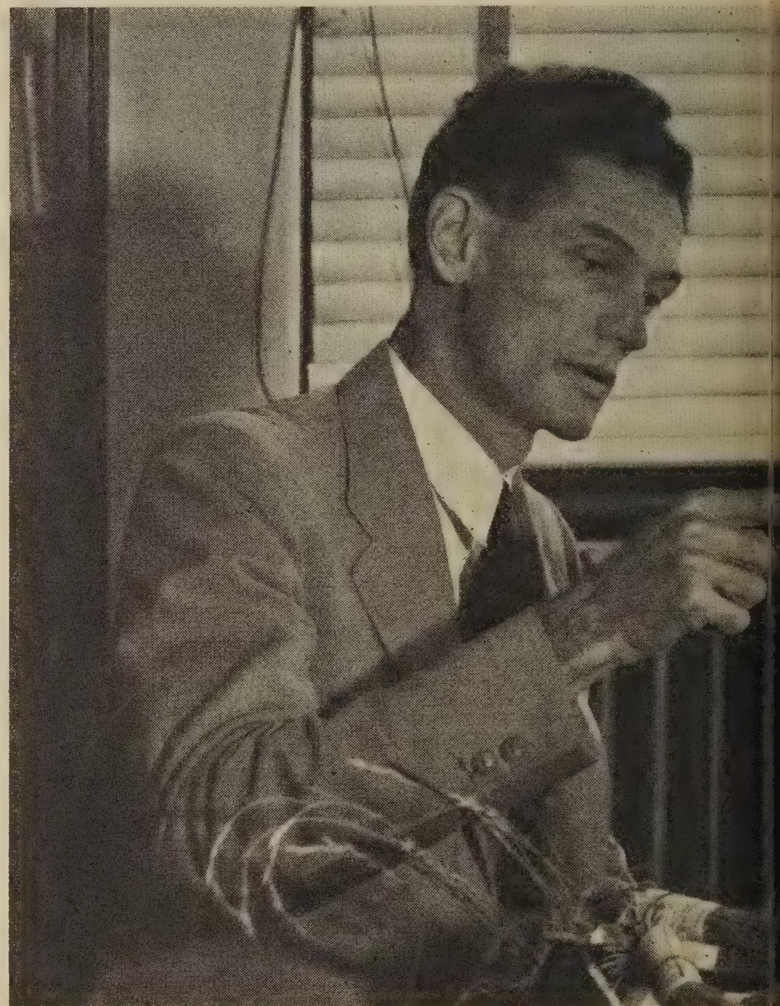
Mixed Plantings

I know you will be gratified, as I was, to learn that all throughout the Northeast there is much interest in mixed plantings of alfalfa and grasses such as timothy, brome, orchard, or tall oat grass. At several of the experiment stations I was told that their experiments indicate some excellent points in favor of mixtures. The mixtures avoid heaving in the alfalfa; they keep out weeds, and avoid bloat in grazing; and the crops make fine hay. And, what is more important, a mixture is most efficacious in the control of erosion. In the Northeast they favor brome and timothy over orchard, tall oat, or meadow fescue, as the former are more palatable to livestock.

Those Northeast farmers are interested, likewise, in winter cover crops seeded at the last cultivation of corn and other row crops. They're using rye, winter barley, and wheat.

Tobacco and Legumes

In the tobacco fields of Maryland I found the same tough problem in erosion control that is so prevalent in Virginia and the Carolinas—that of a poor quality of tobacco from soils treated with legumes. It is my opinion that redtop and domestic rye grass as winter cover crops offer the best solution at the present time.



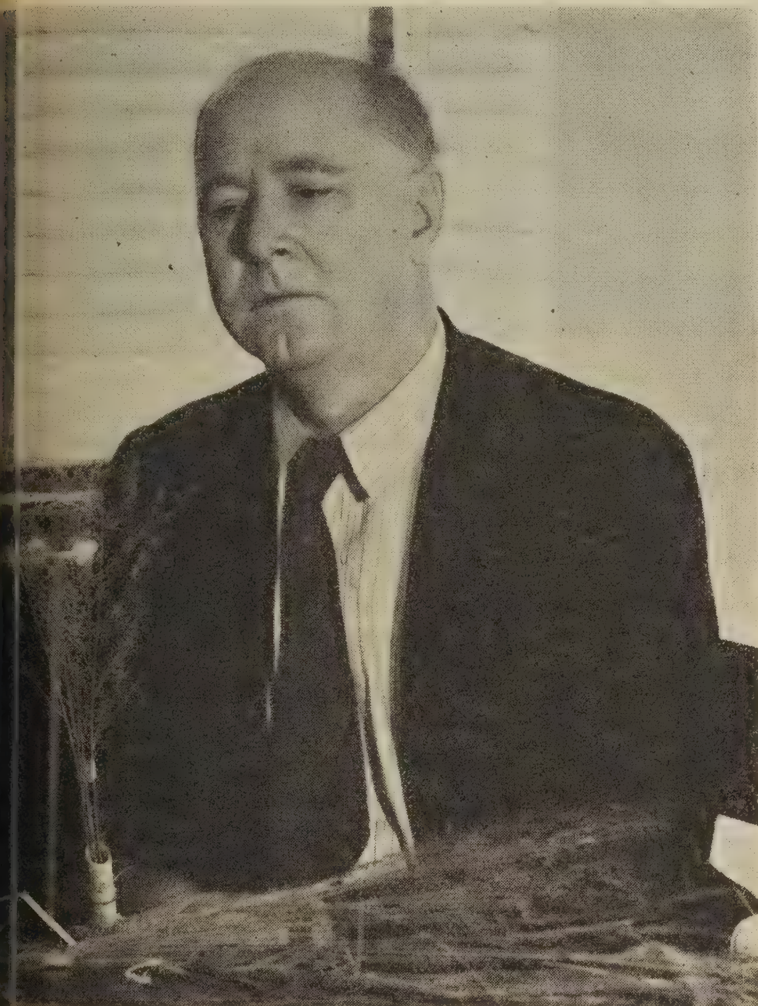
"Switch grass is a valuable perennial pasture plant, no... with the Chief of t...

As to the reseeding of gullies, there is a general tendency to use too many species of plants and too much seed. Experimental results indicate that rather light grass seedings, on poor land, with considerable fertilizer, show to the best advantage. The difficulty about a thick stand of grass on a poor soil is that it develops slowly and soon thins out. The use of two or three species that grow well under such conditions is more economical, and therefore more satisfactory, than to use several species in the hope that some of them will grow.

Narrower Strips

I was interested to know that Maryland farmers who are strip cropping—using corn in strips—have voluntarily reduced the width of the strips. This is true, also, in the Northeast, where corn is cut and

Charles R. Enlow, fresh from a field inspection, sits down with Dr. Bennett for a chat about how farmers are using vegetation to control erosion. His notes yield many interesting suggestions and reflect the progress of one important phase of the Soil Conservation Service program. Mr. Enlow directs the work of the Agronomy Section.



...y liked by grasshoppers." Mr. Enlow talks things over ...rvation Service.

shocked for feed. Reduction of the strip widths allows the farmer to place his shocks on the adjoining meadow strips and, at the same time, clears the corn land. Such a procedure is most convenient when the farmer starts cultivation for seeding of subsequent crops.

There is one thing that should be mentioned in connection with strip cropping—our need for machinery that will work on a contour slope. The bean pullers work well on level land or up and down hill, but on the contour they are not at all satisfactory. This, as you know, is true of other machinery.

Out in Ohio I found an exceptionally fine demonstration of strip cropping on the project at Zanesville. Farmers are pleased with the plan to reduce strip widths for more convenient handling of the corn and of land after the corn is removed. On the Zanesville project it is quite apparent that a good method of stabilizing gullied land is to fence it in and allow grass and weeds to take hold. Such a procedure is more economical than the more elaborate method of building structures and setting trees, and certainly it justifies the purchase of fencing materials.

At Zanesville there is need for additional pasture work. Much could be done in the rotation of permanent pastures, in the planting of supplementary pasture crops, the use of fertilizers, more extensive use of contour furrows, and perhaps some reseeding.

Illinois Meeting

I know you are anxious to hear how the agronomy meeting at Urbana, Ill., turned out. It really was well worth while, although the program was much too ambitious for the one day. Detailed discussion was necessarily limited. It seemed apparent from the meeting, however, that the agronomic program for Region 5 is in general a sound one. It includes the proper use of rotations, strip cropping, contour tillage, the establishment of meadows and pastures, improvement of pastures, and, in some cases, the combination of terracing and strip cropping. I need not tell you that there is always difficulty in deciding the problem of land-use. Given a rapidly eroding area what should be done with it? Should it be retired to trees and pasture? Or, is the land in such condition that cultivation may be continued while best known erosion-control methods are introduced and practiced? It is a question which requires a great deal of thought.

Pasture Disking

In Region 5, I found that pasture disking, with the application of phosphate fertilizers and the seeding of legumes, is a more or less general practice. At the regional meeting I heard considerable argument over the use of small amounts of fine lime in establishing legumes, and I am convinced that this phase of the work needs further investigation.

If you want to see some first-class strip cropping, you'll find it at the project at Winona, Minn. Prac-

As result of snow and wind action, typical North slopes and clay hilltops in State of Washington characterized by bad erosion which makes them submarginal for wheat production. Steep lands shown here dedicated to permanent seeding of alfalfa and grasses; erosion and run-off checked and yields approximating 2 tons of hay to the acre obtained.

tically the entire project is stripped and fences have been moved to the contour. The pasture improvement work is outstanding and the entire project shows a very well-balanced program. All but six farmers in this project are under contract. The type of work in Minnesota can best be judged by the fact that a check-up on land adjacent to one project and two camps showed that 52 farmers outside the project areas have put into effect, of their own volition, part or all of the practices used by the erosion-control program.

Native Grasses Look Good

I am sorry to say that at Mandan, N. Dak., the terrible drought is having its effect on the nursery. The irrigation water available is decidedly limited, and grasshoppers are so numerous that it is almost impossible to increase seed of the plant introductions and native collections. Several of the native grasses, including switchgrass, big and little bluestem, and the wheat grasses, look very good in spite of the severe conditions. On the range land, blue grama did not start growth all summer.

Little bluestem, fighting to retain its hold on life and soil.

The project at Lander, Wyo., presents some interesting problems. One of them is wind erosion which, under irrigation, is very severe on a part of this area. The problem is being handled in excellent shape, however, by forage-crop acreage increase, and by stripping where beans or other crops to be removed are grown. In one instance a farm which was bought for $400 a few months ago is now valued at more than $4,000—the increase due largely to the work of our Service.

Light Rainfall

In this project the rainfall is too light to justify the use of contour furrows. The better method for erosion control on the range land is the provision of water holes for livestock and shorter grazing seasons, both fall and spring. It is well to reduce fall grazing 1 month, so that the grass may mature to seed; while a 15-day reduction in spring grazing allows opportunity for spring growth. Overflow water from the water holes is spread on low level land by the use of a level irrigation ditch. This method is very economical and practical, and it should be tried extensively in other regions.

Out at Pullman, Wash., I found the grass nursery in splendid condition. More than 2,000 strains and species of introduced and native grasses and legumes are under observation, and many look very promising.

New plots have been seeded and it looks as though this nursery is to become outstanding in the future development of grasses.

Effect of Program

You are always interested, Dr. Bennett, in knowing how our demonstration work is spreading beyond the borders of the project areas. I think I am none too extravagant when I say that the Pullman erosion-control project has transformed the surrounding country. With 10 percent of the land on hilltops and steep slopes in permanent hay, the landscape presents a beautiful appearance. An excellent rotation program is being used and at the same time an attempt is being made to encourage the farmers to seed spring wheat. Little erodible fallowed land is visible from the hilltops, and at the present time the area, as viewed from above, appears to be largely covered with vegetation. The present fallow recommended includes rough tillage with crop residues kept at or near the surface.

Reseeding Activities

The project at Emmett, Idaho, shows some excellent results from the reseeding of range or abandoned cultivated land with native and cultivated grasses and legumes. The drilling of grasses on cheat land without soil preparation seems to have real possibilities. Land about Emmett that has been protected

Green manure cover crop of rye offers protection to land and aids fertility.

from grazing shows quite a stand of native perennial bunch grasses, and it is expected that this will improve greatly as time passes, providing the land is protected from grazing for such a time as is required for the grasses to spread and take foothold. This is even more true on the flood-control project at Pocatello,

Reed canary grass, of which Mr. Enlow speaks, is adapted to both wet and dry lands, is an excellent erosion-control crop, and produces a fair quality of hay. (Photographs by courtesy of the Wisconsin College of Agriculture.)

Contour furrows in Texas prove their worth in water- and soil-conservation.

Idaho. There very fine stands of native wheat grass, bluegrasses and fescues, are noticeable with 1 year's protection, whereas in the beginning nothing could be seen but cheat and Russian thistle.

Furrows—Large or Small?

At Pocatello the entire project is being contour furrowed; but here again it is felt that the furrows are too large and too far apart. This practice, if it is to be adopted by the farmers, must be put on a basis whereby the average farmer can carry out the operations with an ordinary plow or similar farm implement. Shallow contour furrows, close together, keep the land passable, mowable, and farmable, and give proper utilization of moisture. Where the problem is largely flood control, however, such as at Pocatello, it may be advisable to include some large furrows.

Damming Lister Used

At Colorado Springs I saw excellent results from the contour furrows established last year, and considerable success has been achieved in reseeding these furrows with several of the native grasses. Sweet clover seedlings in the furrows, and old plants of western wheatgrass, growing up through the ridges, are most promising. Two hundred acres have been seeded to pure stands of different grasses for seed increase. A damming lister has been used very successfully in preparing the land for grass seedings on the contour between contour furrows. This applies particularly to land taken out of cultivation and abandoned land.

The strip cropping at Colorado Springs is an excellent illustration of the use of practical common sense. The farmers' needs are paramount and are given first consideration. In spite of the fact that it has been very dry at Colorado Springs, some good results have been obtained in range seedings with sweet clover, *Elymus canadensis*, *Agropyron smithii*, *Agropyron cristatum*, and smooth brome. Due to the excessive drought, blue grama is not so much in evidence at the present.

Kansas Grass Work

The grass nursery work at Manhattan, Kans., is in excellent shape. Very interesting, and outstanding, is the selection and breeding work conducted by the Kansas Experiment Station and the Bureau of Plant Industry, on bluestems, blue grama, buffalo grass, and other grasses. Seeding methods for various native grasses are being studied. Row seedings, with a firm seed bed, appear to give best results. Con-

siderable progress has been made in Colorado, Kansas, and Oklahoma, in the development of machinery for seeding of native grasses.

All in all, I think I am safe in saying that strip cropping is becoming the outstanding method for control of erosion throughout the country. The main argument against it is that heard in livestock countries—inability to graze the aftermath of hay strips because of their proximity to corn and other growing crops that need to be protected. As for this drawback, it can be overcome by the segregation of crops within fields. For example, all corn can be grown in one field stripped with hay crops; wheat in another, etc. Such an arrangement allows the meadow strips to be grazed, if desirable, after the wheat is cut; and by rotating the corn, wheat, and other nongrazing crops between fields, rotation grazing of the aftermath is possible.

Run-off water used for flood irrigation produced this hay.

ONE FARMER'S PROFITS FROM BLACK LOCUST

By Morris Fonda [1]

Black locust posts valued at $250 to $300 an acre are being harvested from a 20-year growth by Ivy Joyner, Shawneetown, Gallatin County, Ill.

In 1915 Mr. Joyner decided to put some of his rough, hilly ground into tobacco and plowed the area without attention to the seriousness of the erosion problem which might result.

Sprouts Take Field

A few large black locust trees were scattered over the field, however, and in plowing, the roots were disturbed so that a dense growth of locust sprouts resulted. During the next 2 years the locust sprouts became so numerous that all hope to continue cultivation of the field was abandoned. Today the 20-acre plot is producing some of the finest locust trees in Illinois.

By selling regular posts at 20 cents each and corner posts at 50 cents each, Joyner has an income estimated at more than that from the rest of his farm. He is contemplating fencing off the entire area for tree production, even though it is fairly good farming land.

Browsing Permitted

No especial care has been given the stand of locusts, and for the first 3 years about 60 head of sheep and a half dozen head of cattle were allowed to browse at will.

Here's the statistical summary for one cut-over acre the last three seasons:

	Winter 1933-34	Winter 1934-35	Winter 1935-36
Labor-man days	17	17	20
Number of posts	835	835	1,000
Cash received	$250	$250	$300

[1] Forester, Edwardsville, Ill., project, Soil Conservation Service.

WOODLAND ARTICLE IN DECEMBER

Owing to the pressure of upstream engineering material in this issue, it has been found necessary to hold over until December the concluding article in the woodland series: Woodland, a Part of the Farm Plan, by John F. Preston.

HOW MAIN STREET BECAME THE BIG DITCH[1]

By Ross Calvin

The famous old-time floods of Silver City, N. M., made history—but they also made the Big Ditch. And they made it from a standing start in the 10 years from 1895 to 1905.

The first history-making flood occurred July 21, 1895. The rainfall in that month was unusually heavy—six inches, in fact—yet it was less than that of July 1875, about equal to that of September 1875, much less than that of July 1881 and of August 1881. One wonders why the large-scale excavation of the Big Ditch was deferred until 1895. Perhaps the answer will not be difficult to find.

A photograph dated 1891 shows that the level of San Vicente arroyo—known then as Main Street—was practically the same as that of the bordering ground. Across Main Street, near where the opposite end of the bridge now rests, was the famous three-story Timmer house, whose heavy foundations still are traceable. On the opposite corner stood the cabin where Billy the Kid spent his boyhood. Flanking the latter, was the two-story building of *The Silver City Enterprise*. Farther downstream, as we speak of it today, rose the general store of Crawford and Porter, boasting a half million dollar stock, and the mercantile establishment of John Morril. This was the setting of Silver City's Main Street—the San Vicente arroyo of today—during the early nineties. Then on Sunday night, July 29, 1895, came a mighty flood.

Newspaper Description

Says The Silver City Enterprise in its issue last week:

> At 8:45 last Sunday evening the long prayed-for rain came, and came in torrents. The somber clouds which for hours had hung threateningly over the Pinos Altos range, precipitated their pent-up flood upon the steep hillsides adjacent to Chloride Flat, which gathered the waters into a compact volume, from which place it swept down the narrow gorge with terrific force upon the town of Silver City.

[1] This sketch is based upon a longer article by Dr. Calvin which was published in the *New Mexico Magazine*.

Oxen hauling wood on Main Street, Silver City, N. M., *in 1886.*

Looking north up Main Street from Yankee Street crossing during 1900 flood.

This flood, which attained its maximum in force and volume at 10:30, was the largest ever seen at Silver City up to that hour carried away the walls of the Broadway corral, the rear walls of the Broadway hotel, and worked general destruction.

The waters of the first flood had receded below the danger limit at 11:30 when the great bank of clouds which darkened the sky to the northwest came in contact with the towering peak of Bear mountain, the highest in all the Pinos Altos range. As if the bottom of a sea were punctured by the peak, a vast volume of water descended, accumulating in force as it converged in streams from the mountain sides, making a river in the canyon which leads through the town.

At 11:45 this flood struck the town in an immense wave, twelve feet in height and three hundred feet in width, carrying with it everything movable in its path. Down through the heart of town, through the principal business streets, it swept, entering the houses through every crack and crevice, filling cellars full and overflowing, bursting open doors and smashing large windows, running through the first floor of nearly all the houses a depth of two to four feet . . . the velocity must have been fifteen miles per hour . . . The tumult of the waters charged with debris of every kind, carrying boulders weighing tons, trees and fallen timbers from the mountains, which acted as battering rams, struck the buildings with a force and noise which carried consternation and fear to the hearts of those within hearing distance. . . .

The big iron safe which was washed out of the post office was found below the dam, high and dry on one of the banks of the creek. . . .

Doctor Williams, J. R. Johnson, and Sheriff Shannon formed a rescue party which went to the relief of A. J. Loomis and family. Doctor Williams, while carrying the little boy, was thrown down by force of the waters and went under twice, the boy clinging to his neck. Messrs. Johnson and Shannon, holding each other's hands, waded in and caught hold of the doctor, pulling him out with the child, all thoroughly drenched.

Dell Potter and family were asleep at their home in the little cottage next door to the Tremont house, when the flood came on every side of the house, cutting off all possible means of exit and escape. The furniture was all afloat and the family drenched in three feet of water. Mr. Potter took an axe and cut a hole through the roof and placed his family on top of the house and then climbed up himself, and all waited in painful suspense for the waters to recede.

As the years went on and the denudation of the watershed proceeded with no one doing anything to retard or prevent it, the town began to go in for disastrous floods in a really large way. Two occurred on successive afternoons in August, 1903. And it is a conspicuous fact that it no longer required a monthly rainfall of six inches to cause the deluges. That year the rather common August precipitation of 3.8 inches sufficed. Each year as over-grazing and wood-cutting continued, the watershed became more completely denuded.

The editor of the Silver City Independent writes on August 18, 1903:

. . . It was thought that the erection of a dam at the foot of Main Street would put an end to further trouble, but its failure to withstand last week's flood demonstrates that the force of mountain freshets in this country cannot intelligently be calculated upon. . . There is but one absolutely safe remedy, and that is the removal of the business portion of town to a higher ground. . . . The breakwater or dam mentioned above had been erected at a cost of $15,000 to the village, and represented an expression of both hope and despair. It failed in the first test.

Besides the habit of carrying down buildings, saddlehorses, and other livestock, the baleful leaping torrent indulged occasionally in

Looking south down Main Street from Market Street crossing during flood in 1902.

a *tour de force*. Such was the abduction of Judge Newcomb's piano from the second story of a substantial brick building. Eyewitnesses tell what happened. Though a heavy rain had fallen over the mountains, the sun was shining on Silver City. With a sinister roar, the red flood came racing down, battering its banks with floating trees. The front wall of the building, badly undermined, at length fell with a crash. The floor partly robbed of support sagged quietly. The thousand-dollar grand piano rolled forward a bit. As the floor sagged again, the great instrument broke with a ponderous lurch from its moorings, rolled forward—and plunged. The spectators gasped as the massive ebony case went bogging and rolling downstream as though it had been a cigar box.

Afterwards Mr. Carter went to look for the piano. Seven miles downstream he found it.

A combination of causes, of which overgrazing was the chief—overgrazing not alone by range cattle, but

This is the way the street-gully looked in 1906 from Market Street crossing.

"Main Street" in 1936, showing Soil Conservation Service revetment work.

by woodcutter's burros, by pack animals freighting machinery to the mines, by saddle horses, and the like—was carrying denudation to a dangerous extreme in the years before 1895, though the culmination was not reached until July of that year.

Matters continued to grow worse instead of better for several years thereafter, with the result that floods increased in frequency. Meanwhile the formidable Big Ditch which had been Main Street took on the aspect of a canyon. Below town it cut an irregular trough some 15 miles long, which for long stretches is today 50 feet wide and walled in by perpendicular banks 15 feet high. Thus, millions of tons of fertile soil area were carried away, and from lack of water for trees, lawns and flower beds, Silver City took on a look of barrenness.

Then in 1908 The Gila Forest reserve was set aside and placed under Federal control. Very, very slowly nature began to regain its balance, 10 years elapsing before the process of revegetation made much headway. However, vegetative cover gradually increased and floods gradually diminished in number and violence. Now there is far more ground cover, with many young trees over the north end of the watershed, where there is an almost complete absence of old trees. Floods are fewer and smaller because there is less run-off.

For a full generation the Forest Service has been restricting the number of grazing permits in order to prevent damage to the land. It has also vigorously been attempting to prevent forest fire depredations, and nowadays timber-cutting is permitted only on a basis of perpetually-sustained yield. The ruinous drought of 1934 brings out the result of the control with striking effectiveness—for the wells which in former drought years used to be in a chronic state of shortage this year supplied all needs of the town. At a recent meeting the city council attributed a large amount of credit for the increased water supply to the labors of the Civilian Conservation Corps during the preceding year.

So the history of denudation and erosion here has been a typical, though a sad and stupid one. Possibly nowhere in the wide Southwest is there a more striking exhibit of man's interference with nature than Silver City's Big Ditch.

View downstream across Washington Mills Dam, showing silt deposits in foreground. Crest of dam originally 40 feet above stream bed.

SILTING IN NEW RIVER WATERSHED

(*Continued from p. 95*)

results of these surveys are summarized in the following table.

Reservoir	Fields	Washington Mills		Byllesby	Buck
Age (years)	5.67	33.5		23.66	23.66
Original capacity (acre-feet)	183.81	2,954.24		8,892.16	1,225.33
Present capacity (acre-feet)	109.22	511.47		3,538.35	941.51
Sediment:		1922	1936		
Acre-feet	74.59	2,363.96	2,442.77	5,353.81	283.82
Percent original capacity	40.58	80.02	82.69	60.21	23.16
Storage loss per year:		1902–22	1922–36		
Acre-feet	13.16	118.20	5.84	226.28	12.00
Percent original capacity	7.16	4.00	.20	2.54	.98

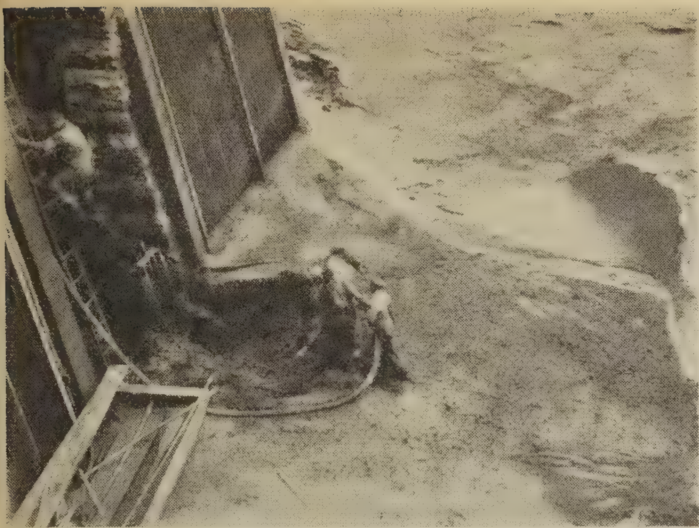
The foregoing table gives the average rates of storage loss for the entire period of each reservoir except Washington Mills. A survey of Washington Mills Reservoir made in 1922 yielded sufficient data so that the storage capacity at that time could be determined. From this information it was possible to compute the amount and rate of storage depletion in the two periods 1902–22 and 1922–36. It was found that in 1922 Washington Mills Reservoir had lost 80.02 percent of its original capacity, at the rate of 118.20 acre-feet per year, and at present is 82.69 percent filled with sediment. These figures indicate that the reservoir was as full as possible in 1922, after a period of 20 years. Since that time practically all sediment entering the reservoir has gone on past the dam because the available storage had decreased beyond the point where additional silt could permanently settle. This would mean that the present capacity of 511.47 acre-feet, which closely represents the capacity during the past 14 years as well, is little more than the volume of a normal section of channel of the same length as the reservoir, maintained by the flow of the New River. As a check on the above conclusion, the approximate velocities which should exist within the range of stage of the New River, in a channel with the given average cross section, were computed. The results show that the high velocities would probably scour material accumulated during periods of low river stage but that lower velocities would allow deposition. In other words, the channel cross section is in a condition of equilibrium, but varies between rather definite limits, determined by maximum and minimum river stages.

Greatly Reduced Capacity

Excessive silting presents a serious problem at Washington Mills. The storage capacity of this reservoir has been so greatly reduced that the operators find it necessary to supplement their own generators at intervals by purchased power. Frequent shut-downs are required in order to sluice out the intake to the generators. Silt accumulates so rapidly in the forebay that a mud valve at the lower end, opened in November 1935, was covered with 6 feet of mud when the valve was again opened 5 months later. A fire hose is used to open up a channel in the silt above the generators by hydraulic methods. This process is necessitated three or four times a year.

Another practice followed at Washington Mills is to open the headgates from the forebay to the river below the dam, allowing stored water and normal discharge to drain out rapidly, washing silt with it. On April 18, 1936, 6.76 acre-feet of silt—equal to 1.32 percent of the storage capacity before draw-down, or 0.23 percent of the original capacity—was flushed from the basin by this process. Better results are prevented by the fact that the bottom of the five headgates are 20 feet or more above the original stream bed, and are all at one end of the dam. Silt is thus

Forebay of Washington Mills Dam almost completely filled with silt.



Clearing silt from mud valve by hydraulic method. Six feet of sediment accumulated here between November 1935 and April 1936.

scoured from a single narrow channel extending about 2,000 feet above the dam, and to only about one-half the depth of the deposit, leaving the greater part untouched.

Buck and Byllesby Reservoirs, particularly the latter, have also lost a large part of their original storage capacity, with a corresponding impairment of full capacity operation at times, during critical low-water season.

The Fields Dam is so low that it has no appreciable storage, but serves for diversion only. Silting has, therefore, had no material effect on plant operation.

Silting Rates in Series

All four of the reservoirs are channel lakes, very little wider than the original river channel. The gradients of the original river channel within the reservoir basins, in feet per mile, were as follows: Washington Mills, 28; Byllesby, 15.6; Buck, 22; Fields, 6.

The results of the surveys indicate that the presence of such a channel-type reservoir even a short distance above a projected dam site is no insurance against storage loss by silting of the new reservoir. For example, although Byllesby Dam is only 9 miles below Washington Mills Dam, it has silted at the rate of 226 acre-feet per year, an annual rate of 2.54 percent of the original capacity. However, Washington Mills Reservoir is estimated to have lost at least 65 percent of its original capacity, and hence most of its effectiveness as a silt trap, by the time Byllesby Dam was constructed. A better example is Buck Reservoir, only 3 miles below Byllesby and constructed at the same time. This reservoir has lost 23 percent of its original storage in a period of 24 years, despite the presence of a much larger reservoir a short distance upstream. Since no tributaries enter the New River in the intervening 3 miles, practically all the sediment in Buck Reservoir must have passed over Byllesby Dam.

Rate of Erosion

In order to develop the significance of the rate of silt accumulation in relation to drainage area, the following data were computed:

Total sediment in all 4 reservoirs	acre-feet	8,154.99
Age of oldest reservoir	years	33.5
Average annual accumulation	acre-feet	243.43

Since the determined average rate of sedimentation in these reservoirs is a general index of minimum rates of net erosion of the watershed, the above figures may be expressed as fol ows:

Total area of watershed	square miles	1,320
Annual accumulation per 100 square miles of drainage area	acre-feet	18.44
Annual accumulation per acre of drainage area	cubic feet	[1] 12.55

It is certain, of course, that an unknown fraction of the erosional debris had passed Washington Mills Dam and on down the New River before the Byllesby and Buck Dams were completed. It is equally certain that another unknown volume has since passed over the latter two dams, the lowest in the series. Therefore, the above figures are less than actual net erosion on the New River watershed. However, they serve to indicate in a general way the probable rates at which further storage depletion of present or additional reservoirs in the New River series may be expected to take place.

Inasmuch as Washington Mills Reservoir is practically full of silt, Byllesby Reservoir is 60 percent full, and the smaller Fields and Buck Dams have but little remaining storage capacity, it is safe to say that, within a comparatively few years, the entire volume of erosional debris from the New River watershed will be passing unchecked downstream, at a rate exceeding 250 acre-feet per year.

This figure, of course, represents only an indeterminate fraction of the net erosion of the watershed, since it is evident that considerable stream-borne sediment passed the whole series of dams and other volumes of sediment are being deposited outside the reservoirs on channel bars and islands. Average losses of soil from the lands of the watershed are, therefore, much greater than 0.63 ton per acre and, as alluvial readjustments progress, a gradual increase in potential rate of silting of any additional reservoir constructed in the valley is to be expected.

[1] 0.63 ton (allowing 100 pounds per cubic foot).

SOLON ROBINSON Pioneer and Agriculturist, Volume I, 1825–45. Edited by Herbert Anthony Kellar. Indianapolis. 1936.

Here is a book that is bound to be hailed with enthusiasm by students of American agriculture, by prairie pioneer specialists in particular, and by the general reader whose interest in the development of the United States throughout the century that is past leads him to delve into the letters and published writings of men and women who traversed with ox teams the boundless rich land to found towns and to build farm homes.

A man of parts, Solon Robinson was first of all wholeheartedly an agriculturist. He wrote with pungency, on many farm subjects, for many papers. He traveled widely and observed keenly; he was a prairie settler—a squatter, in fact—and he was the founder of Crown Point, Indiana. The land in the vicinity of his first prairie cabin was known as Robinson's Prairie, and as such it appears on contemporary maps today. In 1838 he wrote one J. Buel, of the *Albany Cultivator:* "Dear Sir: What can, what must, what shall we do, to elevate the standing of the cultivators of the soil?" and thus began a famous crusade for a National Society of Agriculture which resulted 3 years later in the formation of such an organization. Although the society was short-lived, it set in motion forces which culminated in the establishment of the United States Department of Agriculture in the year 1862.

That Solon Robinson had vision and a progressive spirit is evidenced by his many writings advocating scientific practices which, although truisms in this day, were daring and novel to the farmers of his time. In 1845, while on a visit to the John T. Leigh plantation in Mississippi, Robinson wrote of the "great and indispensable improvement upon Mr. Leigh's farm" in the form of hill-side ditches. "Now, if anybody should ask 'what are hill-side ditches?' I have to say, that the whole of all the numerous hillsides are ditched with one or more ditches, as may be necessary to take up and carry off all the falling water, almost on a level, and winding round till an outlet can be found to discharge it without injury to the land. These ditches are laid off by a level, and are intended to remain permanent fixtures; and all the plowing has to conform to their shape, and as a matter of course, utterly annihilating 'straight rows.' "

On the subject of grasses and terracing to prevent erosion of the soil, Robinson was enthusiastic, and at the same time disgusted with farmers who ignored his soil waste warnings. Of the Bermuda grasslands he wrote, "the tenacity of life in it (Bermuda grass) is so great that some people object to admit it upon their land for fear that they never could get rid of it. In fact it would seem that they would prefer to see their land taking its rapid course down the millions of gullies through which some of the finest soil in the world is sweeping its way rapidly toward the Gulf of Mexico, rather than risk the trouble of getting this grass into their cultivated fields * * *. For, be it known, this is the land of gullies * * *. Now the very worst of these waste gullies can be reclaimed into the best of pasture, and the further waste prevented by Bermuda grass alone, and that in 1 or, at furthest, 2 years. It will even adhere to the perpendicular sides of banks, and in the bottom of ditches it will grow and collect the wash, and again grow up through the accumulating dirt, and again collect another coat of wash so that it not only prevents the further waste, but in a measure will fill up many of the smaller gullies already formed."

Throughout his career Solon Robinson was persistent in his strong advocacy of many and varied farm home and soil improvements. The use of fertilizers—lime, guano, marl, animal manure, swamp muck; deep plowing; better rural architecture and more adequate ventilation in farm dwellings; protection of animals from the weather; keeping of weather records; cultivation of trees, shrubs, and flowers; diversification of crops; better pumpkin pies.

Many of his articles and addresses aroused heated argument among his readers and hearers, and brought forth hundreds of communications supporting his ideas or denouncing them. Often he varied his farm writings by dwelling on other topics. He criticized the State penitentiary system of Tennessee, advocated a flat rate of postage, called attention to a new method of printing invented by Josiah Warren; discussed people and places and ideas encountered in his travels throughout practically every State then in the Union and portions of Canada. At times he resorted to fiction to tell the prairie story, and occasionally he produced some amusing but very bad poetry. In 1864 he produced a book of importance which was called Facts for Farmers.

A few titles from Robinson's writings which appeared in the New York Tribune will give some idea of the scope and variety of his agricultural interests: Perils of Prairie in Winter, Cotton Gin and Presses, Sugar Cane, Rice Culture, Orange Growing in Florida, Production of Turpentine, Home Grown Tea and Coffee, Oaks, Cypress, and Palmetto, Mountain Fruit Farm.

From the point of view of the soil conservationist the publication of the life and letters of Solon Robinson in two volumes during the 1936–37 period is an event both fortunate and timely. We want to know more and all there is to know about the man who, a century ago, wrote of the prairie after the second crop ". . . you have a deep, loose, rich black soil, which as you do unto it, so it will do unto you. The practice generally adopted is to take the skin and starve the body—burning straw and wasting manure—'running over' four times as much land as can be cultivated."

We await with interest the publication of volume 2 of the works of Solon Robinson.

SILTING OF RESERVOIRS. By Henry M. Eakin. Technical Bulletin No. 524, U. S. D. A. July 1936.

This bulletin presents data from silt observations and sediment measurements of significant reservoirs in the southeastern, southern Great Plains, and southwestern type areas of the United States, and shows conclusively that the silting of reservoirs is a practical problem of first order in all three regions, wherever accelerated erosion is in force. The report is designed to give a preliminary outline of the more important aspects of the problem, to summarize the results of studies made heretofore by other agencies, and to present the findings of the Soil Conservation Service during the fiscal year ended June 30, 1935.

Since data point to the fact that in the southeast reservoir silting results chiefly from erosion of deep residual soils as influenced by human occupation, it becomes increasingly apparent that much benefit can come from organized cooperation in the matter of improved terrace slopes. In the southern Great Plains silt detention above reservoir level is indicated, along with terrace and contour cultivation, cover and strip cropping, and control of incipient gullies. Higher rates of silting in the Southwest, due largely to overgrazing and resulting sheet and gully erosion point to the need for restricted grazing, mechanical structures in arroyo and gully, earth barriers above reservoir level in broad tributary outlays, and growth of vegetative screens in delta areas.

U. S. GOVERNMENT PRINTING OFFICE: 1936

PUBLICATIONS ON WATER CONSERVATION

Compiled by Mrs. Etta G. Rogers, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Soil Conservation Service

The Arrest and Prevention of Devastation by Floods. Address. SCS-MP-12. August 1936.

Management and Use of Agricultural Lands Including Farm Woods and Pastures. Address. SCS-MP-13. September 1936.

Soil Conservation and Flood Control. Address. SCS-MP-11. July 1936.

Office of Information, U. S. D. A.

Gullies: How to Control and Reclaim Them. Farmers' Bulletin 1234. Issued February 1922, revised January 1935.

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ONE HUNDRED YEARS IN THE GREAT PLAINS
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Dust Storms
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Sand Drifts

SOIL CONSERVATION

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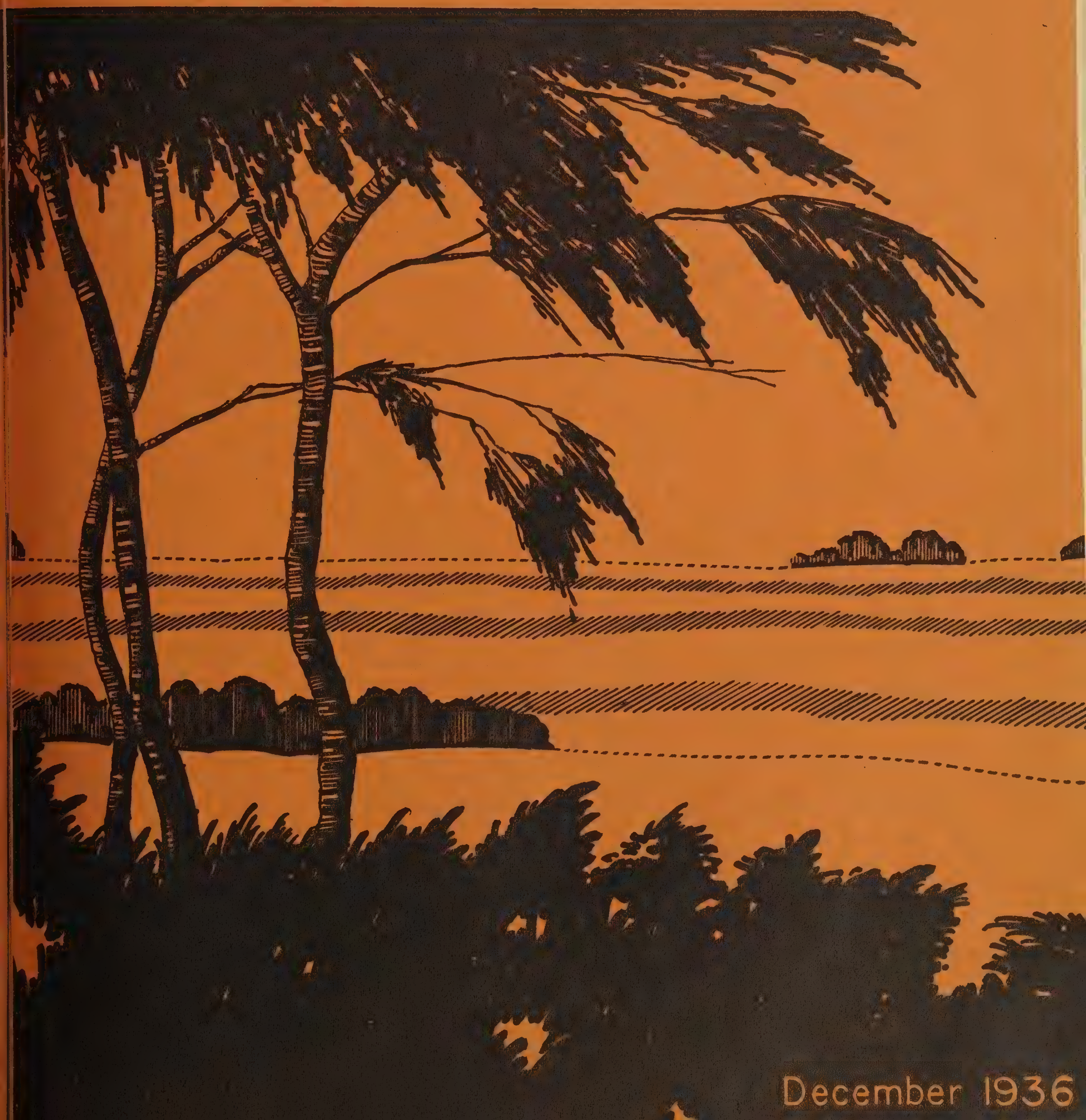

December 1936

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WELLINGTON BRINK — EDITOR

SOIL CONSERVATION

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Winter feeding station for wildlife. In Coon Valley 161 such stations were established during winters of 1933–34 and 1934–35 as part of emergency wildlife conservation program of Soil Conservation Service. They were instrumental in saving pheasants and quail, pending improvement of winter food conditions in the valley.

PROTECTING FIN, FUR, AND FEATHER IN COON VALLEY

By Kenneth Davis

The way is being prepared for permanent wildlife conservation in the oldest of the erosion-control demonstrational areas—Coon Valley, Wis.

Coon Valley is situated in the so-called "Driftless" or unglaciated region of southwestern Wisconsin. Ages ago when the great glacier spread over a large part of North America this region somehow escaped the ice sheet. While the hills all around were rounded off and leveled down by the grinding force of the glacier, those in what is now called Coon Valley kept their sharp ridges and steep slopes.

When the first white settlers came in 1844, the whole area was covered with alternate grasslands and woods. Small fur-bearing animals, grouse, and quail abounded. The central stream draining the area and the smaller streams pouring into it were alive with fish. But this condition did not long prevail.

The settlers cleared many acres of timber land, plowed every available acre that would yield a profit, and turned cattle to graze cut-over as well as wooded hillsides. As a result, the valley for a time was very prosperous, but it wasn't long before it became

Contour terracing and strip cropping not only provide indirect benefits to wildlife through the lessening of soil losses but also direct benefits through the establishment of what wildlife specialists term "the maximum amount of edge." Wildlife tends to congregate along the line separating one type of vegetation from another.

This nest of quail eggs huddled close to a fence post gives evidence of the value of allowing good cover to grow up along fence rows. In Coon Valley the practice of strictly clean farming is being modified to permit the establishing of such cover as this in odd corners.

apparent that something was wrong. Too much steep land had been plowed and too many cattle had been turned on pastures and woodlots.

Soon decreasing crop yields gave evidence that the rich topsoil was being lost. Gullies began to cut gashes in the sloping fields. Coon Creek became muddy with silt and within a brief period of years was transformed from a narrow, deep stream to a shallow, muddy one along which floods were a seasonal occurrence. The wind-blown loess which forms a mantle over the valley is extremely erodible, and it wasn't long before Coon Valley was known as one of the most seriously eroded agricultural sections in Wisconsin.

The effects of all this on wildlife are obvious. Trout, originally abundant in Coon Creek, were almost wholly driven out by the silt and by the shallowing and consequent warming of the stream. The denuding of hillsides, the plowing of every available acre that would yield a profit in crops, the grazing of woodlands—all these meant the destruction of both food and cover for wildlife and death for large numbers of grouse, pheasants, quail, and various small animals. The populations of these birds and animals were greatly depleted.

Thus, when the erosion-control demonstration area was established in 1933, Coon Valley was well on its way toward becoming a ruined, desolate area.

Wildlife and Erosion Control

The immediate task was to effect rather radical changes in farming methods, to coordinate these changes into a single unified program, and to keep the program economically sound.

More than 400 farmers in the watershed agreed to cooperate with the Government for a 5-year period to control erosion on their farms. They agreed to follow the farming plans which they together with erosion specialists worked out for their respective farms. In making these plans, each farm was considered as a

(Continued on p. 112)

A gully before and after establishment of vegetation. Note reclamation of silt effected by wire check dams constructed by Soil Conservation Service. Permanent improvement of environment for wildlife is provided by fencing out and revegetation of gullied areas such as this.

(Continued from p. 110)

unit. In no case did the Federal Government sign a cooperative agreement simply to fix a gully on a farm or to terrace a field. To get these things done, it was necessary that the farmer agree to follow recommended erosion-control practices on the farm as a whole for the 5-year period.

On these farms a concerted attack has been made on all phases of the physical problem of erosion control. Fields have been terraced, and terrace-outlet and gully-control structures have been built. Cropping systems have been rearranged to provide maximum protection to soil of various types and slopes and to maintain fertility. Strip cropping on the contour, and terracing programs, have been introduced for sloping fields. Vegetative and engineering means have been used to prevent stream-bank cutting on valuable bottom land. Denuded hillsides have been planted to trees, and existing woodlands have been fenced out to prevent grazing of them.

Obviously, this program cannot fail to benefit wildlife. In a very real sense wildlife is a product of the soil, and whatever is done to conserve the soil is of benefit to wildlife. With this in mind, the Service has made wildlife work an integral part of its program for Coon Valley. Every effort has been made to fuse the revegetative phases of erosion control with wildlife work and so achieve a coordinated program designed to conserve wildlife, as well as soil and water.

How the Program Works

The revegetation of stream banks, gullied areas, and hillsides is not only an important part of erosion-control work but also provides a splendid opportunity for wildlife conservation. The foresters and agronomists of the Service have cooperated with the biologists by including in their plantings species having special value as wildlife food or cover.

On the edge of wooded areas having good wildlife cover, food patches consisting of various grains and sorghums are being planted each year by the cooperating farmers. At the present time there are 312 such food patches in the valley, and quail and pheasants have derived considerable benefit from them. Records kept on this work show that practically every game bird in the valley has made some use of these food patches.

Various types of food patches are being tried in the area in an effort to determine which is most satisfactory. Some of them are cultivated and some are not. They contain different species and varieties of plants. Most of the patches, however, are not experimental.

This food-patch program was supplemented, during the first 2 years of erosion-control work, by emergency winter-feeding designed to carry through the cold season many birds and small animals which otherwise would have starved to death, due to the destruction of wildlife food through agricultural operations. This was carried out by establishing feeding stations—generally barrel-feeders placed beneath a crude shelter built of boughs and brush—at strategic points throughout the valley. Some 161 of these stations were operated in the valley during the first two winters.

Last winter this supplementary feeding program was discontinued by the Service, as it was felt that winter-food conditions in the valley had been sufficiently improved to provide ample nourishment for existing populations of birds and animals. By that time, the interest of farmers in the program was assured.

Farmer Cooperation

The wildlife and erosion-control phases of the Service have in most cases been conducted jointly. Except for some outsiders who are copying the wildlife methods, all farmers aiding in wildlife work are also cooperating in erosion-control work. Three hundred and three of the eight hundred farms in the area are now under agreement to follow recommended practices for wildlife conservation, and it is on these farms that the food patches are located.

The wildlife cooperators are developing a new concept of the relationship of wildlife to environment and are endeavoring to establish as favorable an environment for wildlife on their farms as possible. This involves a few minor changes in farming methods. For instance, one of the most serious factors affecting winter-food conditions in the valley has been the practice of clean farming. Farmers have been in the habit of removing every bit of grain from the grain fields at harvest, all corn shocks and all sorghums in the fall, and have kept their fence rows clean, removing bushes and weeds which might otherwise have served as cover for wildlife. Now, however, in consideration of the birds and small animals, they are leaving strips of corn or occasionally a series of corn shocks on areas adjacent to good cover. Fence rows are left to grow up in grass and bushes. In addition, odd corners are being planted to trees and shrubs to provide permanent cover.

Some of these farmers are also establishing winter-feeding programs of their own, placing deposits of corn

Wildlife food patches like this one planted at the edge of good cover are established on over 300 farms in Coon Valley. Planted to corn, sorghums, and other suitable crops, they constitute an important feature of the permanent wildlife program of the Soil Conservation Service and mean the difference between life and death for many birds and animals during the long winter months.

or grain at strategic points in the wooded portions of their farms.

One farmer in the valley, George Dingledien, stared in astonishment through the dusk of a cold winter evening last year at a covey of quail roosting in a spruce tree only a few yards from his front porch. The covey spent the nights there throughout the whole of the winter season. This same farmer fed 53 quail on his place during the winter of 1934–35 and reports a marked increase in quail and pheasant since he established a feeding program and fenced off his woodlots to exclude grazing stock.

Extent of the Work

The Service has planted 721 acres of trees in Coon Valley and has placed 12,388 acres of woodland under protection from fire and grazing. On the 12,388 acres, the forest undergrowth, no longer annually destroyed by grazing cattle, will provide not only more effective control of run-off but also food and cover for wildlife.

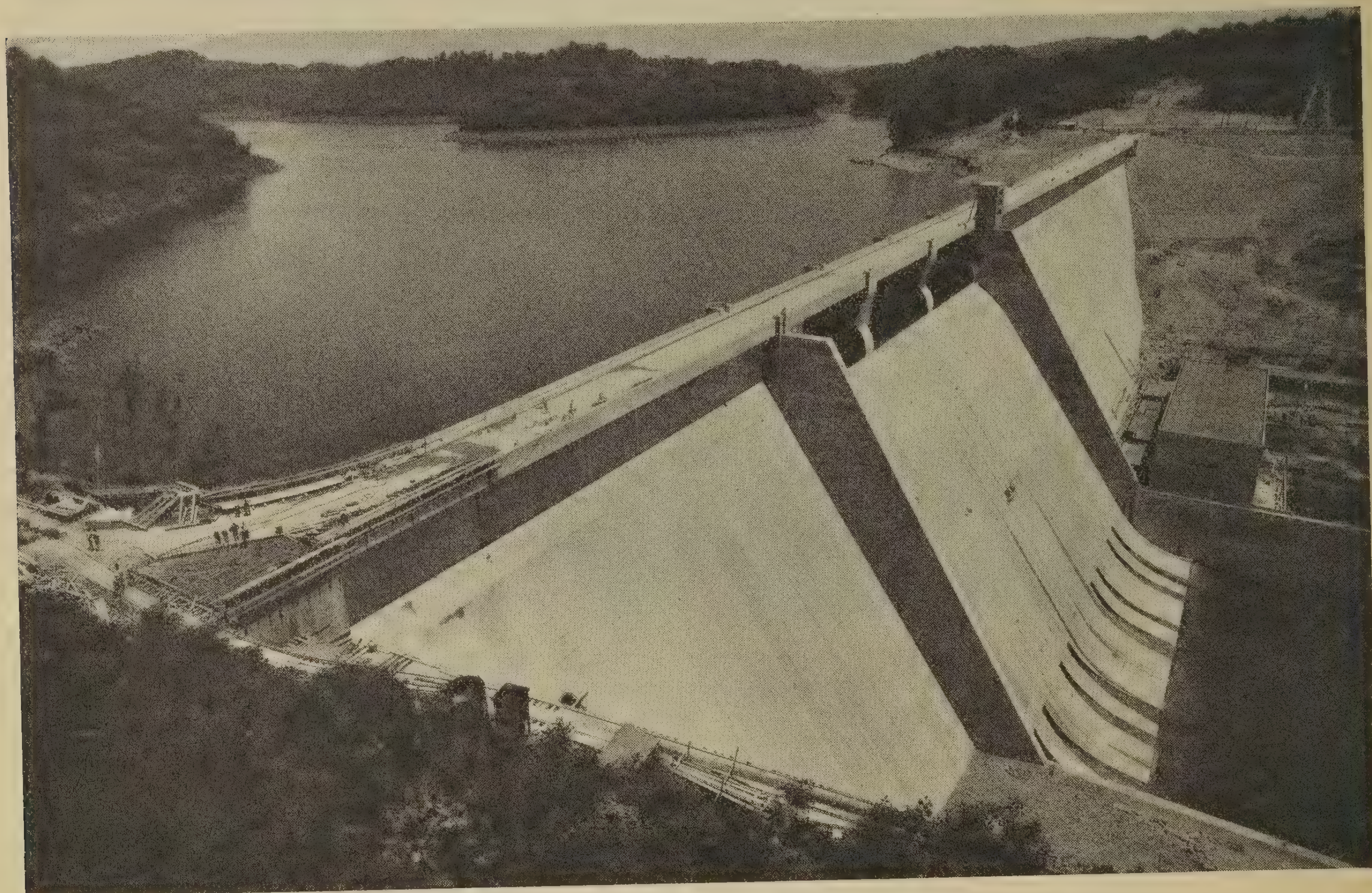
In addition to the woody plantings in woodland areas, the Service, as part of its erosion-control operations, has planted over 26 acres of trees for wildlife. All in all, 31,600 woody plants have been planted in the valley, chosen especially for their value as wildlife food or cover.

Close cooperation has been maintained with State agencies in conducting the wildlife work, and especially with Aldo Leopold, of the University of Wisconsin, who was instrumental in establishing wildlife conservation as a part of the erosion-control program. During the last 2 years, the Wisconsin Conservation Department has provided 1,000 pheasant eggs which the Soil Conservation Service used to aid in restocking the valley. The Service and the 4-H clubs in the valley area have cooperated extensively, carrying out a number of projects designed to increase population of quail, grouse, and pheasants. Cooperators are now posting their lands for regulated hunting. In this they are receiving help from the Wisconsin Conservation Department.

Looking to the Future

In Coon Valley today, one can see the inception of a future in which the land will be treated kindly rather than as an unlimited resource to be continuously exploited. Agriculture will then be conceived as a cooperative rather than strictly competitive enterprise, in which man and nature will live in harmony rather than at odds with each other. A stable agriculture will then support a stable community. In the woods, fields, and streams, wildlife will again abound.

T. V. A. PLANTS TREES, BUILDS CHECK DAMS, IN MOVE TO PROTECT NORRIS DAM FROM SILTING



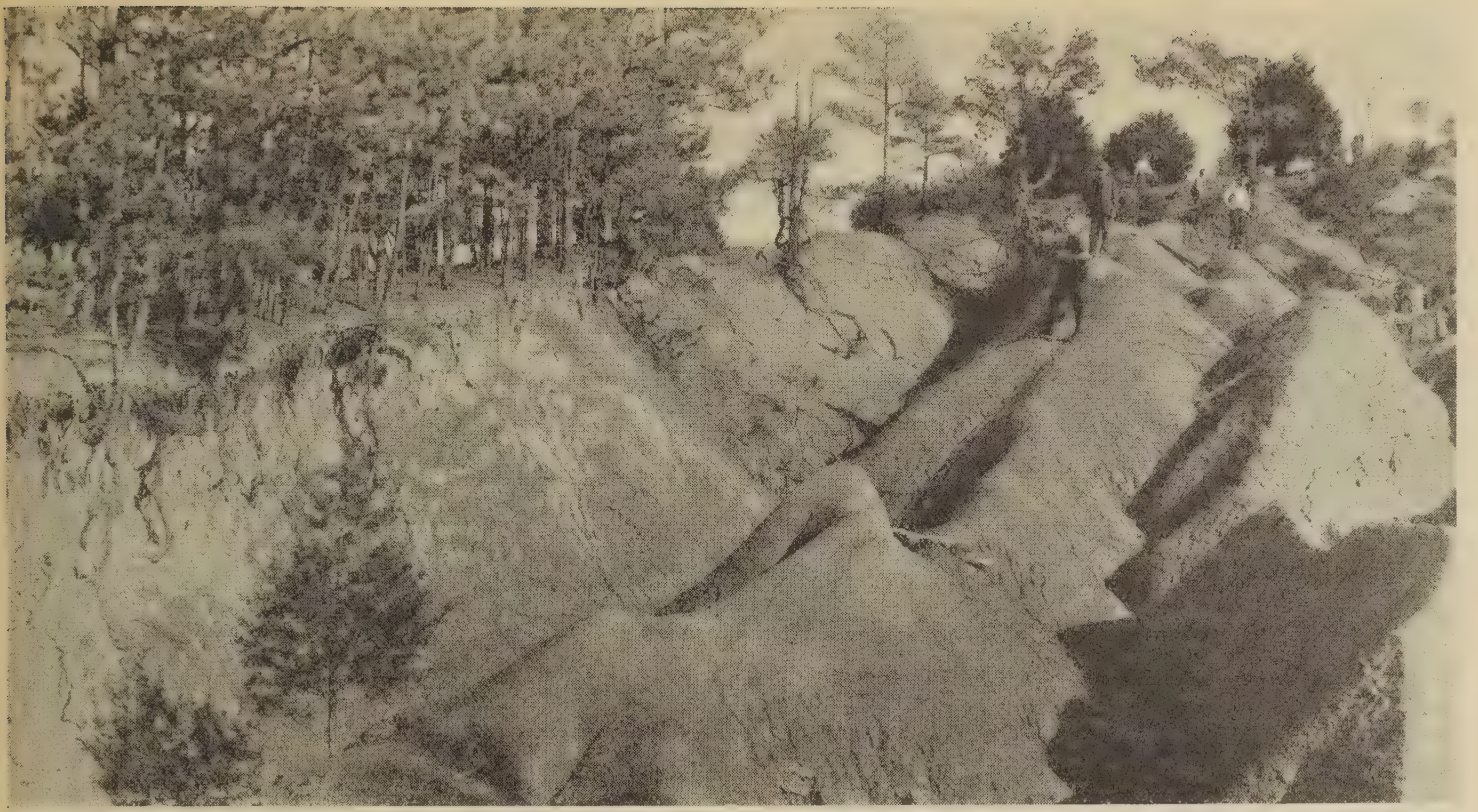
Norris Dam—an investment to be protected from the effects of erosion.

Deep saw-tooth gullies in the Clinch River water shed are being paved with straw and brush, held down by wire and stakes, stabilized by black locusts and lespedeza, as a practical means to erosion control and the protection of the large Norris Dam investment.

Regional foresters and other specialists of the Soil Conservation Service, in late October, devoted two crowded days to an inspection of work being done under direction of the forestry division of the Tennessee Valley Authority. A long cavalcade of motor cars, each with a T. V. A. technician in the driver's seat, traced a serpentine course from dawn to sunset along main highways, then secondary and, finally, tertiary roads, to remote and almost inaccessible hillsides of abandoned farms and submarginal lands. Here is bad land practice. Here is erosion at its devilish worst. Here is an active threat to the permanent usefulness of Norris Dam. Here is a challenge which forestry and engineering must help to meet.

Ten principal stops were made the first day, eleven the second, and at each halting point there were snake fences to climb, barbwire to pass, rough country for the testing of high boots and corduroy. With dogwood, sourwood, tulip poplar, maple, sumac, gum and oak painting a back drop of autumnal colors, lecturers explained numerous projects involving engineering and reforestation control of gullies, and brush matting on sheet-washing areas.

At the Clinton Forest Nursery 15 million trees per year are now being produced for the planting of T. V. A. lands and for use on cooperative erosion-control projects throughout the Tennessee Valley. Still in an early stage of development, the nursery has a possible maximum production of 40 million trees. Included in the establishment is cone storage and extractory equipment designed to supply seed for both this and another forest nursery operated by T. V. A. The latter devotes itself to nursery experimentation in pollination, budding, grafting and propagation, does field testing, checks stock developed at the nursery, and conducts a system of scouting for superior native species.



Before treatment.

Forestry activities are conducted with an eye toward conserving not only soil but fish and wildlife as well. The Norris fish hatchery includes three hatching pools, a daphnia pool for food supply, an administration building, and pumping equipment. Fish hatched here will be placed in the 26-acre lake formed by the Doak's Creek fish dam, another point of interest on the itinerary.

The E. T. Campbell project is typical of those visited in which an effort has been made to control erosion by using check dams in only a few of the larger gullies.

(*Continued on p. 130*)

After treatment.

DAYTON MEETING HEARS ENLOW ON ASIATIC PLANT-HUNTING—CONSIDERS AGRONOMIC PRACTICES

Members of the Soil Conservation Service in region 3 met in Dayton, Ohio, October 27–28, to discuss agronomic practices and farm-management problems in connection with erosion control.

At a night session Charles R. Enlow, head of the agronomy section, Washington, D. C., described his 7-months' expedition with H. L. Westover, into central Asia in search of grasses, legumes, shrubs, and trees which might prove valuable for erosion control in this country.[1] His remarks were illustrated by lantern slides.

Searched Mountains and Deserts

Entering the central Asiatic sections through Moscow, where Russian scientists extended them every courtesy in arranging their trip, the two plant explorers searched extensively through the mountains and deserts for promising plant species. This section of central Asia grows many legumes, and other plant species which either have been adapted to conditions in the United States or give promise of being useful here. Among other valuable plant species found in central Asia are strains of Turkestan alfalfa which have proved resistant to alfalfa wilt, a disease which has become prevalent in some of the midwestern States in recent years.

Enlow and Westover brought back some 2,400 samples of seed, and since their return have received another 2,000 seed samples through arrangements made with Russian scientists. Many of these species were obtained in Turkey, the arid regions of which they also visited. These seeds have been planted in semiarid States of the Middle West. They are being tried out under varying climatic conditions from the Dakotas to Oklahoma, as well as in Arizona. In addition to the seeds of promising grasses, the plant explorers also brought back numerous species of nuts and stolons of roots of several plants which do not produce viable seed.

Strip Widths Discussed

Among the questions discussed in the regional offices was the most desirable width of strips where strip cropping is practiced. Results from demonstrations on farms throughout the country indicate that strips should vary from 50 to 150 feet in width, Walter V. Kell, agronomist from the Washington office, said. The width varied principally with the slope, the soil type, the degree of erosion, and the rotation. Strips of 200 feet in width generally have not reduced erosion sufficiently, while strips narrower than 50 feet tend to become impractical.

Contour furrows in pastures give considerable promise of holding rain or melting snow, where it falls on the land and where it will do the most good. The Soil Conservation Service demonstrations have been under widely varying climatic, soil, and slope conditions, and in almost all instances the furrows have proved that they hold water, prevent quick run-off, and encourage absorption of moisture. Such facts have been established by measuring and comparing penetration on contoured pastures with adjacent pastures not contour-furrowed.

Contour Furrows Considered

Arnold S. Dahl, in charge of eastern pasture work for the Washington office, reported on the effectiveness of various methods of constructing contour furrows. The demonstrations, he said, seem to indicate that shallow furrows close together give better results than deep furrows not so close together. Shallow furrows and more of them do not turn infertile subsoil to the surface and do not prevent passage of farm implements over the area, yet appear to be effective in checking water run-off, according to Mr. Enlow.

An idea of the amount of water which can be held by contour furrows may be gathered from calculations under given conditions. For example, each linear foot of contour furrow 6 inches deep and 18 inches wide will hold 0.75 cubic foot of water or 5.63 gallons. Thus, the water-holding capacity of contour furrows on a 160-acre pasture, with furrows averaging 20 feet apart, is approximately 2,500,000 gallons.

Economic phases of the soil-conservation work were given much attention in the discussions. Agricultural extension specialists of Ohio, Indiana, and Kentucky took part in the conference. E. J. Utz, head of erosion-control practices in Washington, D. C., also addressed the meeting.

"Our aim is to recommend soil-conservation methods which are within reach of every farmer", said T. C.

(*Continued on p. 130*)

[1] Mr. Enlow and Mr. Westover made this trip in 1934 as members of the Bureau of Plant Industry.

WOODLAND, A PART OF THE FARM PLAN[1]

By John F. Preston[2]

Excellent erosion and run-off control, plus salable products that add greatly to the value of the farmer's woodland.

The owner of a country estate plans to use every part of his land for whatever purpose it is best adapted—agriculture, game, scenery, recreation, or for any other which promises pleasure or profit. The American farmer usually has quite a different conception. His idea of his farm consists of an aggregation of fields, pasture, and orchards. All other land included within the limits of the farm boundaries, such as woods, brush, ravines, is too often looked upon as waste land.

The farmer's conception is a natural heritage from early days, the result of the struggle of the pioneer to hew a farm out of the wilderness. The "winning of the West" was achieved by means of a march through the woods, a gradual conquest of the wooded slopes of the Appalachian Mountains for possession of the wooded areas of eastern Kentucky, Tennessee, West Virginia, and Ohio.

The Farm Woods in Pioneer Days

In those days the only market for the products of the forest was that which supplied the farmer's domestic needs. This was appreciable, and while it did not bring in cash, was an important means of making the farm a success. From the woods the farmer secured all the material for his house, his barn, and his fences. Fuel to cook his meals, warm his house, and smoke his meat, came from his woods. The mast from the forest trees fed his hogs, and the stream which flowed through his milk house had its source in the woods higher up the slope. To find a place for his corn field and to provide pasture for his cows and horses, however, he had to cut down the forest and, oftentimes, burn the logs.

As the pioneers pushed westward, they came into a country which was not all woods, but where the forest was broken by big prairies; and still farther west the forest gave way completely to the prairie. Here the point of view of the farmer changed somewhat, and under the stimulus of various laws offering inducements for tree plantations efforts were made to grow shade trees, shelterbelts, and even plantations of trees. These first attempts at forest plantations usually failed, and in the prairie country today the general idea of the woods and ravines as the waste part of the farm still prevails.

Perhaps it was the fact that the forest openings furnished more or less forage and that the nut trees in the denser part furnished mast for the hogs which gave rise to the thought that the farm woodland was chiefly valuable as forage for stock. In any case, the chief use which most farmers have found for their woodland areas is the grazing of livestock. It is strange that this idea has grown in spite of the fact that, actually, the farm woodlands offer very little feed for cattle and horses and that the chief advantages are shade and refuge from insects.

On the other hand, as time marched on from pioneer days, some farmers realized that the woodland is a profitable part of the farm and that its use as pasture is unprofitable. There are now many isolated instances where farmers have fenced stock out of the

[1] This is the concluding article of a series.

[2] Head, Woodland Section, Soil Conservation Service.

woods and have deliberately managed their woodlands for a timber crop. In spite of the lack of management and in spite of the abuse, the census figures show that the woodland products of the farm constitute a considerable part of the total farm revenue.

When we consider the farmer's point of view, his misuse of his woods, it is indeed remarkable that the woodlands have persisted; and the fact that they are still there is a splendid example of the recuperative ability of Mother Nature.

Point of View Changes

More and more, however, is it becoming recognized by the farmers that not all land can be cropped and that the so-called waste land, including the woods, should be managed for whatever resource it will provide. We even find some farmers who are managing brush land for production of game, either for themselves or for purposes of leasing to hunters. The Soil Conservation Service is one of the organizations which is gradually bringing about this change in point of view. The Government's plan for control of soil erosion on the farm contemplates the use of every part of the farm, and there rarely is any waste land which cannot be brought into the scope of the plan for producing revenue or other benefits. One of the first things that is brought to the attention of the farmer is that he cannot have a forest which will continue to yield valuable returns if livestock are allowed to run under the trees. The woodland must be fenced and nature given a chance.

Farm Plan and Woodland

Proper management of the farm woods is, therefore, a part of the farm plan as set up by the Soil Conservation Service for the control of erosion. The approach to the problem of woodland management on a farm is different when this woods must fit into the entire plan than when considered by itself and merely from the standpoint of good forestry practice. There are a number of reasons why this is true:

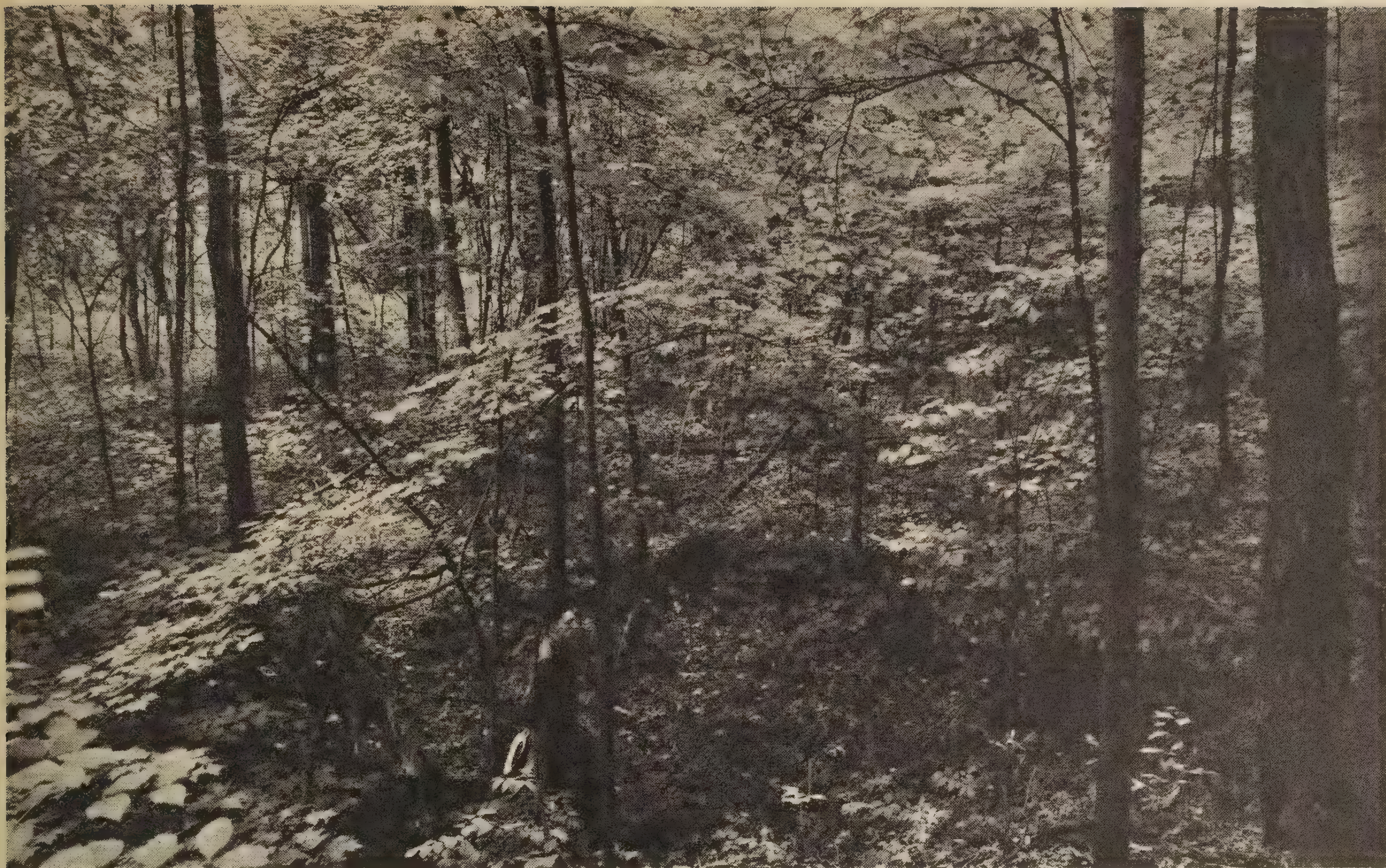
It is not a question of what the woods can be made to produce because of certain site and stand conditions and because certain species are present which have a particular market value; on the contrary, the woods must be managed from the point of view of what the farm as a whole can be made to produce with the woodland resource a contributing factor. In some instances the acreage of farm woodland may actually be reduced by the farm plan; and always the needs of the farmer control the character of management which the forester prescribes.

Type of Farm an Indicator

The type of farm indicates usually the kind of forest management to be adopted. Obviously a stock farm requires more posts and corral poles, and more barns and sheds, than a grain farm. Up in the North Woods, maple sirup is an important product, and the management must provide not only the right conditions for the growth of maple trees, but there must be an abundance of fuel wood with which to fire the evaporators. Farther south, where tobacco is an important crop, flue curing requires about 2 cords of pine wood per acre of tobacco. Therefore, the number of acres of tobacco to be grown on the farm determines the minimum acreage for the piney woods if the fuel is to be obtained from the farm unit. Should there be a large percentage of the farm area in woods, the opportunity to grow timber for the general market becomes an important issue. There are other uses, also, for forests on the farm, such as picnic grounds, hunting preserves, and for purely aesthetic values. All of us have seen farms where the woods have the same artistic relation to the farm as the shrubbery to a home in the city. It forms the background which makes that farm home desirable and, therefore, has a value far beyond the products which may come from the woods. In such cases, the forest management is greatly modified over what it might be otherwise.

Farmers' Needs Come First

In many cases, the fact that the woods provide labor for men and teams in the winter when no other work is available is sufficient reason for their maintenance and care. Even where the sale value of the products obtained covers little more than the labor cost, with no overhead for idle labor of men and horses, this becomes obviously an important matter. Management of the woodland part of the farm may be affected by this fact; and the management may be directed to produce an inferior product merely because there is a sure market for it and winter labor is the most important consideration. I know of several farmers who manage their woods with the idea of having enough lumber available in case the barn burns. This may be poor forest management, but from the standpoint of the farmer and his peculiar needs, it may be the best type of management. Here the forest provides insurance, and if the farmer prefers



The value of the farm woods as a place of beauty and recreation is recognized not only by the family living on the farm but by the prospective purchaser if this farm should be offered for sale.

that kind of insurance, the woodland management must be modified so as to give him just that. I remember one farm, and doubtless there are numerous other examples, where, before the farm plan was made, a forester had marked the trees for cutting from the woods from the standpoint of growing saw-logs, for which the species and the site seemed to be eminently adapted. After the farm plan was made by the Soil Conservation Service, it developed that the farmer's chief requirements were for fuel wood, and that he could better afford to go to the nearest lumber yard and buy the lumber which he occasionally needed. The management of the woodland was changed therefore to provide, not saw-logs, but fuel, which meant a short rotation instead of a long one.

These are a few of the considerations which bring about a change in the forester's point of view if he is developing a management plan for the farmer's woods as an integral part of the general farm plan developed by the Soil Conservation Service. It is radically different from the plan which is likely to be developed if other parts of the farm are not considered. If there is a new plan worked out by the agronomist which gives the farmer more pasture on 10 acres than he had before on 20, it becomes possible to retire some of the less profitable pasture lands from crop production and plant them to forest trees. Again the management of the farmer's woods is influenced by the farm plan.

The foresters in the Soil Conservation Service must be farmers as well as foresters. They must look at the farm from the farmer's point of view and make a plan for the woods only after having acquired an intimate knowledge of what the farmer needs, and after knowing what changes are being made by the agronomists and other specialists who are working on the same job. The farmer's woodland is not a separate entity but a part of the farm. It is rapidly graduating from the status of a waste area, a woods pasture—burned, abused, and neglected—to a respectable unit of the farm worthy of the same attention, the same care which the farmer gives to his corn field or his pasture land. There are values in the woods, worthy of the attention being bestowed upon them.

VALUABLE FOR REFERENCE

Agricultural Statistics 1936 may be obtained from the Superintendent of Documents, Washington, D. C., at 50 cents per copy. It constitutes a complete statistical record of the agricultural year.

LOOKING DOWN A 5-YEAR ROAD IN SOUTHWESTERN OHIO

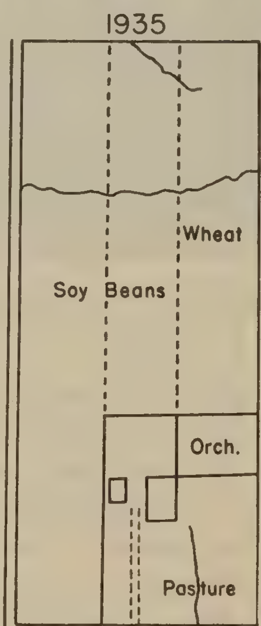
By Wellington Brink

THIS, my companion told me, was the Wayne Stephenson farm. He stopped the car, put on the hand brake. I fumbled in my brief case for a land-use map I had picked up in the Hamilton office.

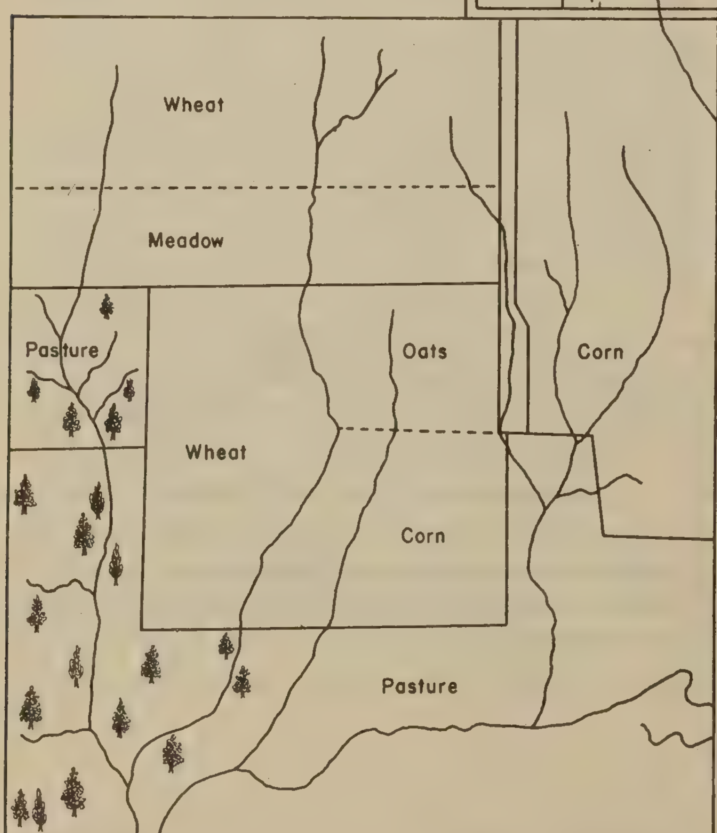
It had looked to me like a bit of a pipe dream, back there in the shielded office of the Indian Creek watershed project. But here was the thing in actuality, unrolling on a grander scale, not on a flat wall but on the fertile silt loam of southwestern Ohio. Yes, here it was—a good, well-managed farm in 1936, on its way toward becoming a much better-managed farm in 1940. Large rectangular fields were beginning to narrow and lengthen and curve. A fence or two had been removed, a fence or two had been constructed. Hay would be allotted more space, pasture too. Woodland's importance would be emphasized. Planning, rotating, strip cropping, terracing, fertilizing, good seed, furrowing in pastures; season by season they would be adding up to soil saved, productivity increased, and revenues enhanced by 1940.

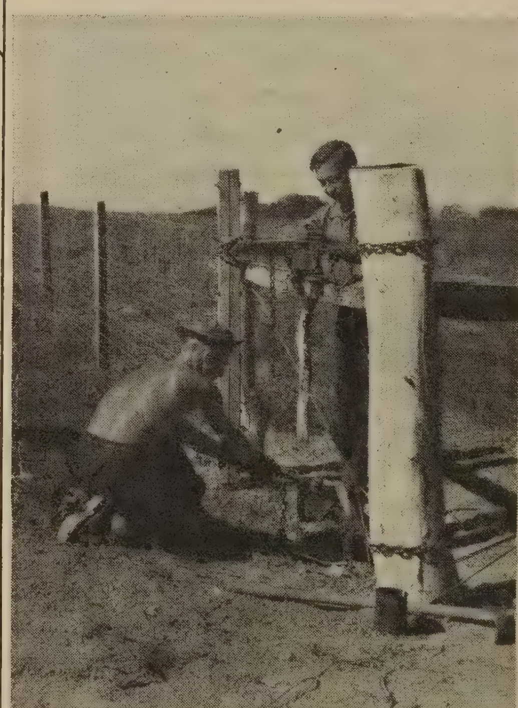
I shook the map out flat, so that I could see all three sketches together. In pink, green, blue, buff, and white it lay square, straight, and chunky in 1935. In 1936 it showed the fields beginning to assume a modern, stream-line form. In 1940 a permanent, better-balanced system was obviously in effect with grain and meadow alternating in narrow strips, shifting season by season up and down the gentle slopes.

LAND USE MAP

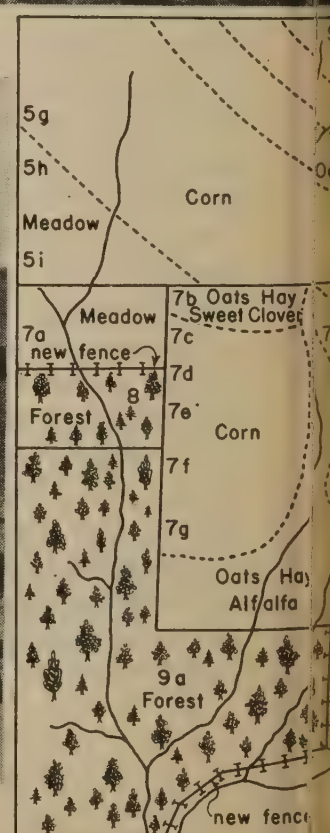


Pasture Furrows in Ohio





Fence Building in Ohio



All this might still be in pipe-dream category except for its being founded on statistics and sweat, experiments and experience—and except for its finding its way from the paper in my hand to the fields by the roadside. The so-called "soil-productivity balance"[1] applicable to this farm is worth looking at.

	Positive	Negative
1935		
Productivity effect due to crops	0.5984	0.8721
Erosion factor	....	.3891
Net soil productivity balance	....	.6634
1938–40		
Productivity effect due to crops	1.2100	.6264
Erosion factor	....	.2387
Net soil productivity balance	.3449	....

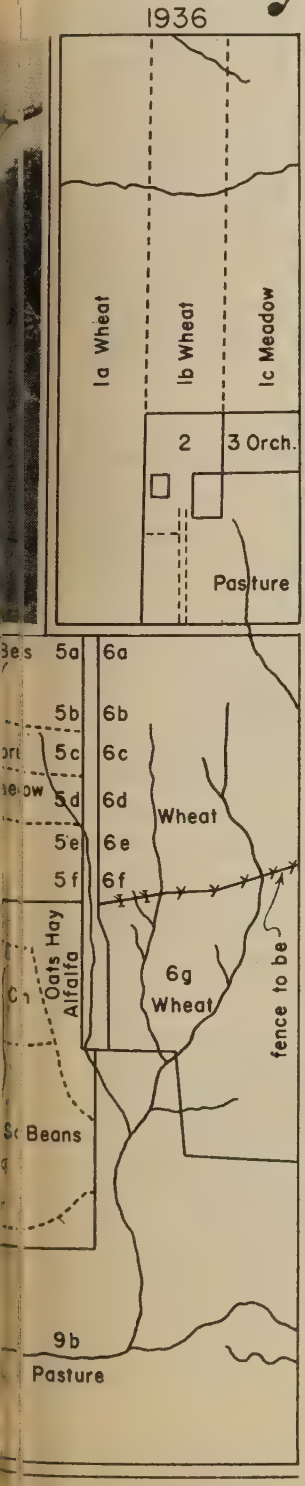
[1] A statistical yardstick explained in Bulletin 175, Agricultural Extension Service, the Ohio State University.

Erosion factors have been established by experiment for every soil type in Ohio. And it is proposed to achieve the higher "productivity effect" by stretching out the rotation period on these 171 acres, by retiring erodible land, and by introducing soil-building crops. On this place, which is at present understocked, it is not so much a matter of boosting yields as of balancing them, of assuring the safety of the farm investment, and of adding to the cash income.

Ponds and Pastures

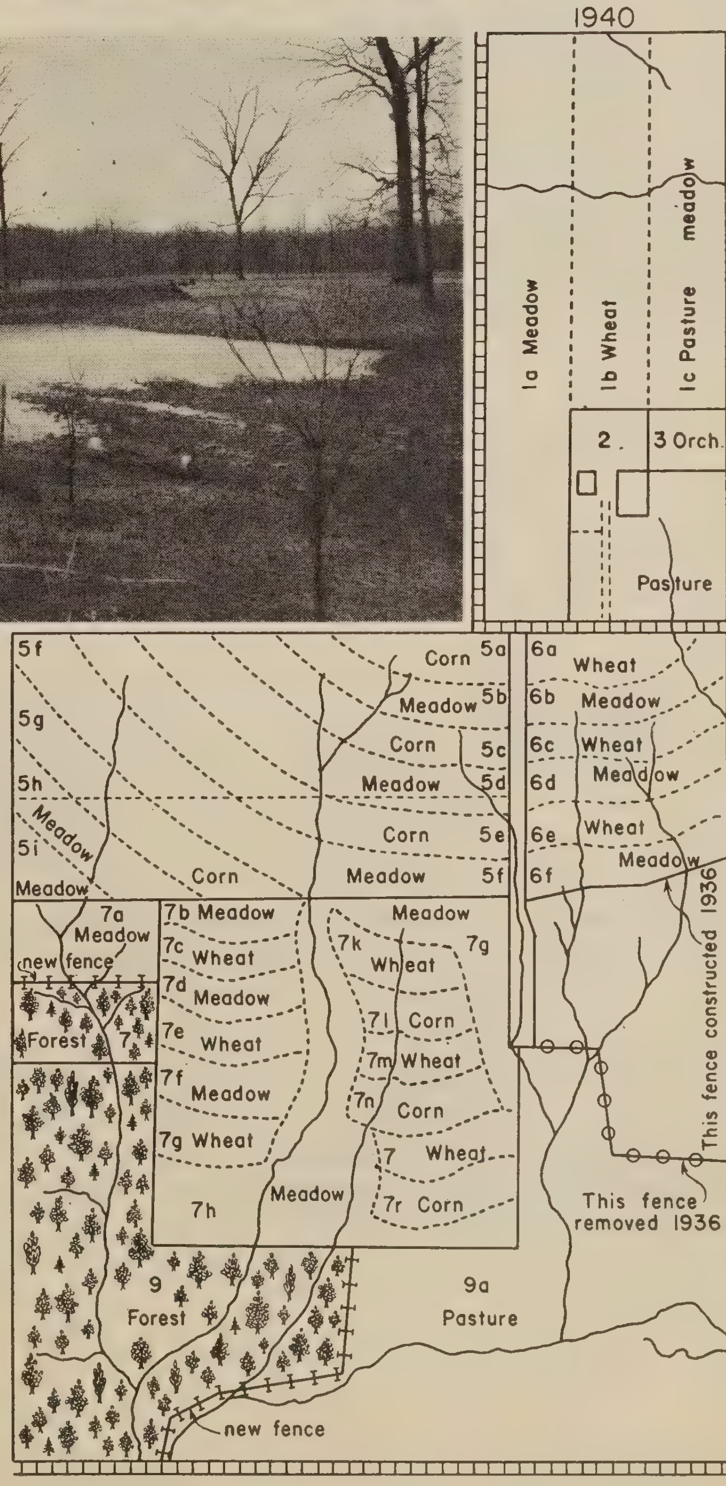
Fields looked greener now than in many months. Four years out of the last six have felt the heavy whip of drought. The livestock industry has suffered under

Wayne Stephenson Farm



The stock pond shown above is typical of many farm reservoirs constructed in Butler County, Ohio, under supervision of the Soil Conservation Service. It converted a useless field into pasture land, supplied water for cattle, took care of excess water flowing from nearby terraces, and provided food and refuge for wildlife.

A system of four terraces, protecting approximately 15 acres from erosion, drains into this reservoir by way of a roadside ditch and a diversion channel. A sodded spillway carries overflow water into a wooded area, which in turn prevents soil washing. Water is piped from this pond to a tank for watering the cattle. Shrubs are to be planted around the reservoir to supply food and cover for wildlife.



its lash. Farmers sought water by drilling deep wells, and too often they found salt. They constructed shallow wells and ponds, and not infrequently their work went for naught when inexpertly built outlets gave way. A happy solution finally was reached in the cooperation of farmer and Government. Today, as we rode along the graveled side roads we stopped now and then to inspect numerous stock-watering pools built to serve the needs of both today and tomorrow. Owners or tenants had scooped the basins, thrown up the rims, implanted the fences roundabout to prevent damage by hoofs. Soil Conservation Service engineers, using W. P. A. labor, had fashioned cores and outlets. And at the troughs below, the thirsty throats of dry coming Julys and Augusts promise to find relief. Ponds such as these sometimes constitute the crux of the land-use program, for they enable lands to be in pasture that could not otherwise be so used.

Well-Used Acres

Indian Creek watershed is bosomed on some of the fairest soils of America: Russel, Fincastle, Delmar, Brookston. It is embraced in a blended, balanced design of agriculture. Its custodians are mostly pastoral in ancestry, schooled in the arts of animal and soil husbandry—as eager for good ideas as for good seed. So it is natural that they give ready ear to the demonstration project's slogan, "A proper use for every acre—every acre in its proper use." Farm planning becomes a normal process to their orderly minds, and for the most part they are glad to profit by collaborating with trained economists, agronomists, foresters, engineers.

Planned Production

Another interesting example of plan transference from drawing board to countryside is the Earl Creek farm. Here, in 5 years, with a positive "net soil productivity balance" of 0.2505 attained under a thoughtful rearrangement and readjustment, the number of animal units may be expected to be raised from 42 to 48.5, the production of hay to be lifted from 39 tons to 76 tons, the grain yield to be increased from 1,440 bushels to 1,817 bushels, and the pasturage to be expanded from 17.5 acres to 33.9 acres. On these 155 acres of slight slope, it is expected that contour cultivation, pasture furrows, and perhaps a small amount of strip cropping will constitute the principal physical restraints on roving soil.

Gully plugging absorbs only 10 percent of the labor expended on erosion control in this project. The usual practice is to plant trees in the gashes, protect them from livestock and fire, and let nature take its course.

Fence moving, on the other hand, is the biggest single work item. It is regarded as wisdom to lead the barriers around the slopes, put them where they will stand guard over woodland, pastures, and ponds and assist in contour-farming operations.

There had been recent rains, and water was backed up behind pasture furrows and terraces—sufficient testimony that their assigned functions were being properly fulfilled.

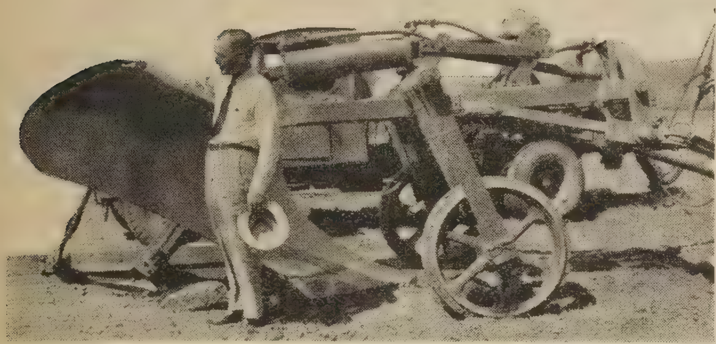
Stream banks, too, were seen holding at various points of stress, in gratitude toward low-cost jetties constructed by W. P. A. workers.

There are seven Civilian Conservation Corps camps attached to the area. One of these is located in proximity to limestone and not far from coal, and in the absence of grinders some much-needed lime burning was undertaken. First a flooring of logs was put in position. Then a covering of litter was laid down. And finally, layers of coal and stone were alternated. Vents for a draft, and a roof of earth, completed the kiln, and the fuel was started on its 3 weeks' smoldering. It was a demonstration of how local materials may profitably be utilized.

Nowhere, I suppose, do we find a wider variety of erosion-control measures than in this area high in hogs, low in pasture, and thoroughly worth saving for tomorrow's tomorrow. Normally there is a brown topsoil 10 to 12 inches thick, under which is a bright yellowish-brown subsoil often quite fertile when given enough moisture and a mead of organic matter. Go farther down and we encounter a gravelly material which can be downright troublesome. The slopes are long and gentle. Pastures are the key. What sometimes happens when farmers restrict their pastures is that they lean upon pasture meadows, run short of hay, feed more and more grain. Redrafting farm plans on a 5-year basis is one way to halt this dangerous drift. And in doing so, they are using pastures, alfalfa, soil-conserving practices as the fulcrum for achieving a better balance. They are looking at their farms as a whole rather than as patchworks of separate fields. They are consolidating their properties and their homes, adding attractiveness to utility, providing trees and cover for quail—endeavoring to discover a proper use for every acre and to put every acre to its proper use.

TURNING THE EARTH UPSIDE DOWN WITH A 4-FOOT PLOW

By Walter V. Kell[1]



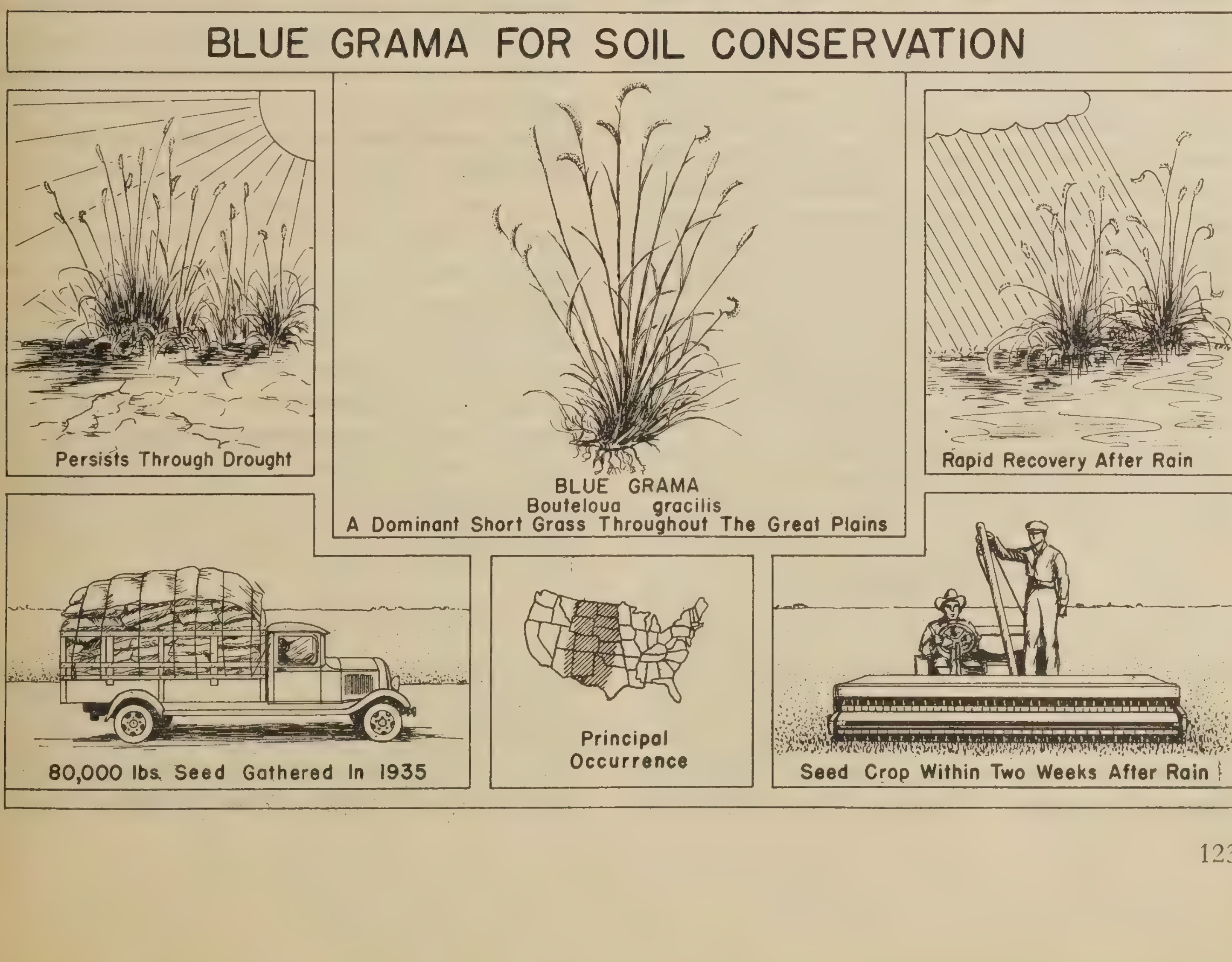
When a few years ago a large dam broke in Southern California, the flood waters not only wrought destruction to life and property but left on top of the fertile valley soils a heavy deposit of unproductive sediment. In many of the highly developed citrus groves this deposit actually had to be hauled off the land to save the trees. In some cases as much as 2,000 to 3,000 cubic yards per acre were removed—a very expensive operation.

On those open valleys not yet planted to citrus trees, more economical methods were sought for restoring the fertile soil to the surface where it could be made to produce. A big 4-foot plow is today doing the job at a cost of $35 per acre. It is possible that this is the largest plow in the world. Two large caterpillar tractors are required to pull it. It turns over a 4-foot furrow.

The flood is a reminder of what might happen to these same valleys, as well as many others, if the fertile topsoil is allowed to wash from the hills until the subsoil is exposed.

Crop rotations, cover crops, contour tillage with strip cropping, and a better use of the crop residue on the bean farms, should supply safeguards.

[1]Associate head, Agronomy Section, Soil Conservation Service.



CONTROL AND USE OF LITTLE WATERS IN FRANCE

Excerpts from an address by M. Albert Magnein, Inspector General of Administration of Waters and Forests, Paris, France, Before the Upstream Engineering Conference in Washington, D. C., September 22, 1936

In the eighteenth century the river Leysse had 8 disastrous floods and in the following century, 38. The floods had, therefore, become 4.7 times more frequent. In 1738, the forest covered 13,500 acres, or 53.2 percent of the drainage basin. In 1910, the forest covered only 9,870 acres. It had lost 27 percent, or more than a quarter of its former extent. * * *

A speed at the bottom of a small stream of 10 feet per second is sufficient to erode the hardest rock, such as granite; 5 feet per second to wear down schist and conglomerate; and one-half foot per second to wear through soft clay. As man has no more influence upon the abundance of atmospheric water, storms, or melting snow than on the geological composition of the soil, he must try to reduce the velocity of the torrents. * * *

Government Reforestation

For the entire French territory between 1861 and 1935 the French Administration of Waters and Forests has reforested approximately 1,190,000 acres at a cost of 317 million francs, of which 57 million francs have been spent for corrective works. The social importance of works of correction and reforestation executed in the Alps is considerable. It was not only necessary to protect roads cut from mud flows, but it was particularly important not to allow streams to carry away top soil from a village or the smallest hamlet. These areas, cultivated with affection by the present inhabitants help to keep these people in their home communities. If a flood carries away the soil, this inhabited center will definitely disappear. Later on, the forest which has saved these mountain people from exile and preserved the soil, will also give them work. * * *

Enabling Legislation

Works of correction of torrents and the regulation of pasturage cannot be done without injuring certain private interests. Although the works are executed in the public interest. it would be illusory to count on spontaneous. and even less enthusiastic cooperation from all landowners. A number of laws permit the Forestry Administration to overcome resistance which might occur. The first was the law of July 28, 1860, on the reforestation of mountains; the second of June 8, 1864, on the replanting of grazing lands; and finally the law of April 4, 1862, which abrogated and replaced the two preceding laws. By virtue of the present legislation, the necessary works for the restoration of soil can be declared to be "affected with a public interest" which permits the application of eminent domain on that land where work must be done. The law of August 16, 1913, has well supplemented that of April 4, 1882, by permitting the declaration "affected with a public interest" to be applied not only for construction works against erosion but also for those aiming at the prevention of floods. * * *

Stabilizing Sand Dunes

One must also contend with wind, which, under certain conditions, can bring about the destruction of arable soil by covering it up with sand. This happened in the Landes before works of dune fixation were undertaken by the forestry service in 1862 and has been continued ever since. The technique of dune fixation is as follows: At a distance of between 100 to 150 feet from the reach of the highest waves, a seacoast dune is built by means of special fences. The work is continued until a dune 40 to 50 feet above sea level is created. In the shelter of this artificial dune various grasses are planted. A cover of branches is used to stop the wind from displacing the sand which eventually is stabilized naturally by the growing grass. The area covered by such works along the French coast is approximately 250,000 acres and extends about 720 miles along the coast line. The works built since 1864 have cost 13,000,000 francs and the annual maintenance costs are in the neighborhood of 200,000 francs. * * *

Laws to Protect the Forests

It is not all tc create forests; one must afterward protect them just as well as those which have been in existence before. French legislation has passed two laws for this purpose—that of 1859 on clearing of land and that of 1922 on forest protection. Restric-

tive measures concerning the clearing of land date far back. An ordinance of Francis I of January 1518 and one of Henry III in 1588 prohibited cutting on royal forests and on those of others subject to certain public rights. The ordinance of 1669 reiterated this prohibition. The law of September 29, 1791, passed during the revolution, gave landowners the full freedom of their woods, but cuttings became so heavy that the Government, by the law of April 29, 1803, was forced to restrict the right of destroying forests. During the years which followed, the texts of these laws were modified and finally consolidated into the law of June 18, 1859, which is still in force. This law provides for the prohibition of clearing land whenever the forests are necessary to protect mountain soil and slopes; for the protection of the soil from the sea and the movement of sand; for the protection of land in border zones; and, for the benefit of the public health. As one may see, the scope of the law is wide and it is frequently possible to oppose the destruction of a forest by its owner.

Excessive exploitation may lead to the more or less complete disappearance of forests. The law of April 28, 1922, classifies as "protection forests" those which are considered necessary to protect mountain areas and mountain slopes from avalanches and erosion, and to prevent floods and the movement of sand. In forests so classified the owner is compelled to apply for an official cutting permit from the Administration of Waters and Forests. Without such a permit no cutting can be done except by special authorization.

Fire Prevention

Fire is another enemy which threatens forests and against which precautionary measures had to be taken. First of all, preventive measures were necessary, such as the creation of firebreaks, the organization of fireguards possessing a system of rapid communications, and the institution of fire-fighting corps in all localities adjoining the forests. The two most dangerous regions are in the Landes and along the Mediterranean coast where the pine trees and the underbrush are particularly vulnerable. During the summer season, fire watchers are on duty at vantage points and give an alarm as soon as they notice smoke. In the Province the system was brought to perfection by the construction of watch towers equipped with radio transmitters. These stations can communicate at all times during the day and night with the radio-marine station in Marseilles, and the operator notifies the fire service immediately by telephone. A law of 1924 defines the obligations of forest owners with regard to fire fighting.

Fish Farming

The region of Dombes forms the southern part of the district of Bresse. It is a rolling plateau and the soil is formed of a glacial clay, hardly permeable. The upper part of the soil can be more or less penetrated by cultivating machines, but beyond 20 inches the soil becomes so compact that it is difficult to dig it with a spade. Because of the profile of this region and the impermeability of the soil, the Dombes is covered with ponds which for many years have been used for the raising of fish. Previously, the region of Dombes was unhealthful because of these permanent ponds, but the situation has changed since corrective practices have been introduced. During the entire period that these lands are under water, the bottom of the pond becomes richer through deposited organic matter of animal and vegetable origin. When the pond is drained, this dung assures a fine crop of cereal plants, especially oats.

The system of fish raising and cereal farming together with the existence of a railroad for the rapid transportation of the product raised have brought to the Dombes a prosperity which is in direct contrast to its previous poverty. According to statistics, population density has increased and health conditions are very favorable.

The surface of the Dombes is covered with rolling hills. In the basins between these hills ponds have been made by building dams in order to retain flood waters. A system of sluice gates provides for the drainage of the pond and grills hold back the fish. On the bottom of the pond there is a system of small channels and trenches to facilitate the drainage of the impermeable soil. In the middle of the pond is constructed a large ditch which traverses the full length of the pond and ends at the sluice gate. The fish pond is established at the deepest spot. At the periphery of the pond girdling ditches are built. Finally, parallel to the main ditch are dug a series of other ditches which are connected with one another and with the central ditch through a series of small channels. Two adjoining channels are separated by a ridge. By this arrangement, the water falling on the surface of the soil is drained and gathered in the main ditch; when the sluice gate is open, the water escapes through an overflow channel.

The filling of the pond takes place usually in October. First, the soil is plowed in a direction perpendicular

(*Continued on p. 130*)

SIGNIFICANCE OF NATURAL VEGETATION IN PLANNING EROSION CONTROL AND WILDLIFE MANAGEMENT [1]

By Ben Osborn and H. L. Whitaker [2]

The vegetation of an area provides a ready appraisal of the environment. In this scene from the West Tuay Creek project, Ottawa, Kans., is shown the original boundary between a forest and a grassland type of vegetation, indicating a transition from a relatively moist to a relatively dry habitat. The grass has been almost entirely removed by overgrazing but the forest community still occupies its original position.

What makes a plant grow, thrive, and reproduce? The factors are many, their relationships complex. Science cannot yet answer the question with completeness or certainty. Man has not yet the knowledge which would enable him to analyze the soil, the climate, and whatever else might be involved, and say definitely what species of plants will grow, or how well.

The growing plant alone is the answer to the question "Will it grow?" It is the sum total of all the plus and minus factors in its environment.[3] At a given time the plants growing upon a piece of land constitute an empirical measure of all the factors and influences which have touched their lives.

As Clements says, "the judgment of many individuals is more dependable than that of one and the verdict of many different kinds of plants grouped in a community is much better. In consequence, the study of the chief societies of a region affords the best measure of the climate and its possibilities, while the minor ones will reveal the significant variations in soil and topography."[4]

The vegetation of an area, considered as a composite, therefore, provides a ready appraisal of the environment.

When this vegetation is seen to divide itself into distinct types, and these types in turn are seen to confine themselves to different portions of the area under observation, it is plain that differences in soil, in climate, in topography, or in treatment by mankind are at work with sufficient force to affect plant growth. These differences are of the greatest importance to the agronomist, the forester, the range manager, and the wildlife technician, each of whom is concerned with growing special types of plants or managing the natural vegetation to obtain special results. The success of any of these operations depends to a large extent upon how well they are coordinated with the natural conditions under which they are practiced.

[1] This is the first of two articles on *Mapping Natural Vegetation as a Background for Erosion Control and Wildlife Management Plans.*

[2] Mr. Whitaker is regional biologist, Mr. Osborn is junior biologist, Region 7, Soil Conservation Service.

[3] Clements, F. E., 1920. Plant indicators; the relation of plant communities to process and practices. Carnegie Institution, Publication 290. Washington, D. C. 388 pages.

[4] Quoted by A. E. Rupp in "Choosing the Right Tree" in *Soil Conservation*, Sept. 1936. From News Service Bulletin, vol. III, no. 31.

Agronomists have learned to study the soil and to adapt their practices to its varying qualities. The soil is but one factor, though a most important one, in plant environment. It is as much the product of the vegetation as the vegetation is the product of it.[5] It is the result of plant life, and to a lesser extent, of animal life, working through the ages upon weathered rock materials. Its nature, therefore, varies with the type of vegetation which occupies it and has produced it. Vegetation consequently is an index to the type and quality of the soil. It may detect, and through its distribution may reveal, significant differences which remain hidden to man in his present imperfect mastery of soil science.

Vegetation and Erosion

The value of vegetation in holding the soil where it is formed—i. e., in erosion control—is widely, though imperfectly, recognized. The practical experiments of the agricultural colleges and erosion experiment stations consistently show vegetation to be the most effective and the cheapest method of preventing erosion. Evidence of this nature is accumulating rapidly, although the surface of the subject has hardly more than been touched.

[5] Kellogg, C. E. Development and significance of the great soil groups of the United States. U. S. Dept. Agr., Misc. Pub. 229. 40 pages. 1936.

Another approach is exemplified by the laboratory experiments of Kramer and Weaver [6] on the relative efficiency of roots and tops in protecting the soil from erosion and Weaver and Harmon's [7] study on the quantity of living plant materials in prairie soils in relation to run-off and soil erosion. These studies seek to determine by controlled experimental procedure to what extent, and why, various types of vegetation protect the soil. Their findings help to explain the results of some of the more practical trials under field conditions, and lay the basis for a scientific understanding of the relation between vegetation and erosion control.

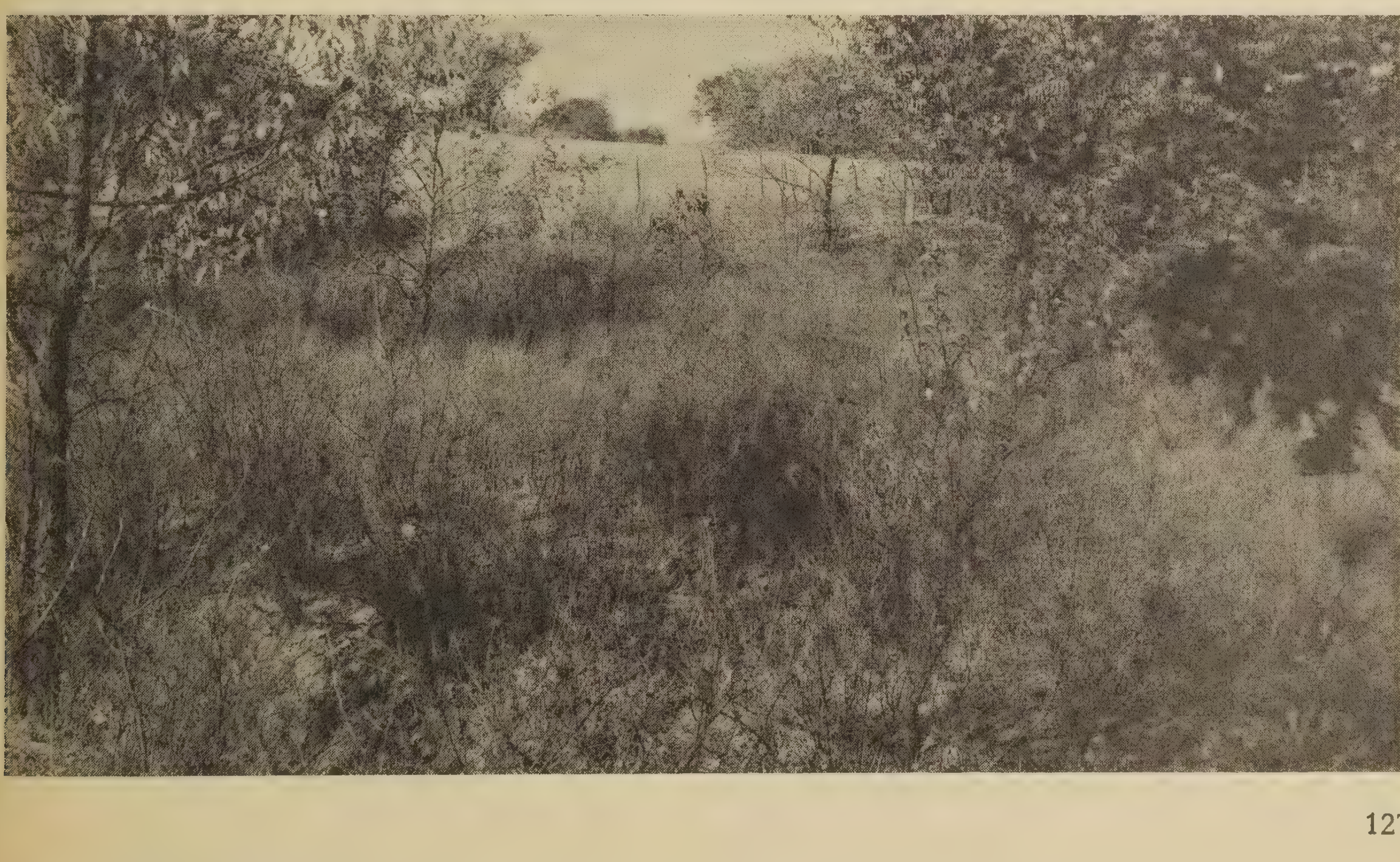
Another phase of the subject, and one which has scarcely been recognized, is the possible correlation between natural plant communities and the degree of erosion, both before and after disburbance. Booth,[8] in a study of this kind conducted as a master-of-science problem at the University of Oklahoma, found that in Cleveland County, Okla., the greatest degree of erosion had occurred in the Oak-Hickory (*Quercus-*

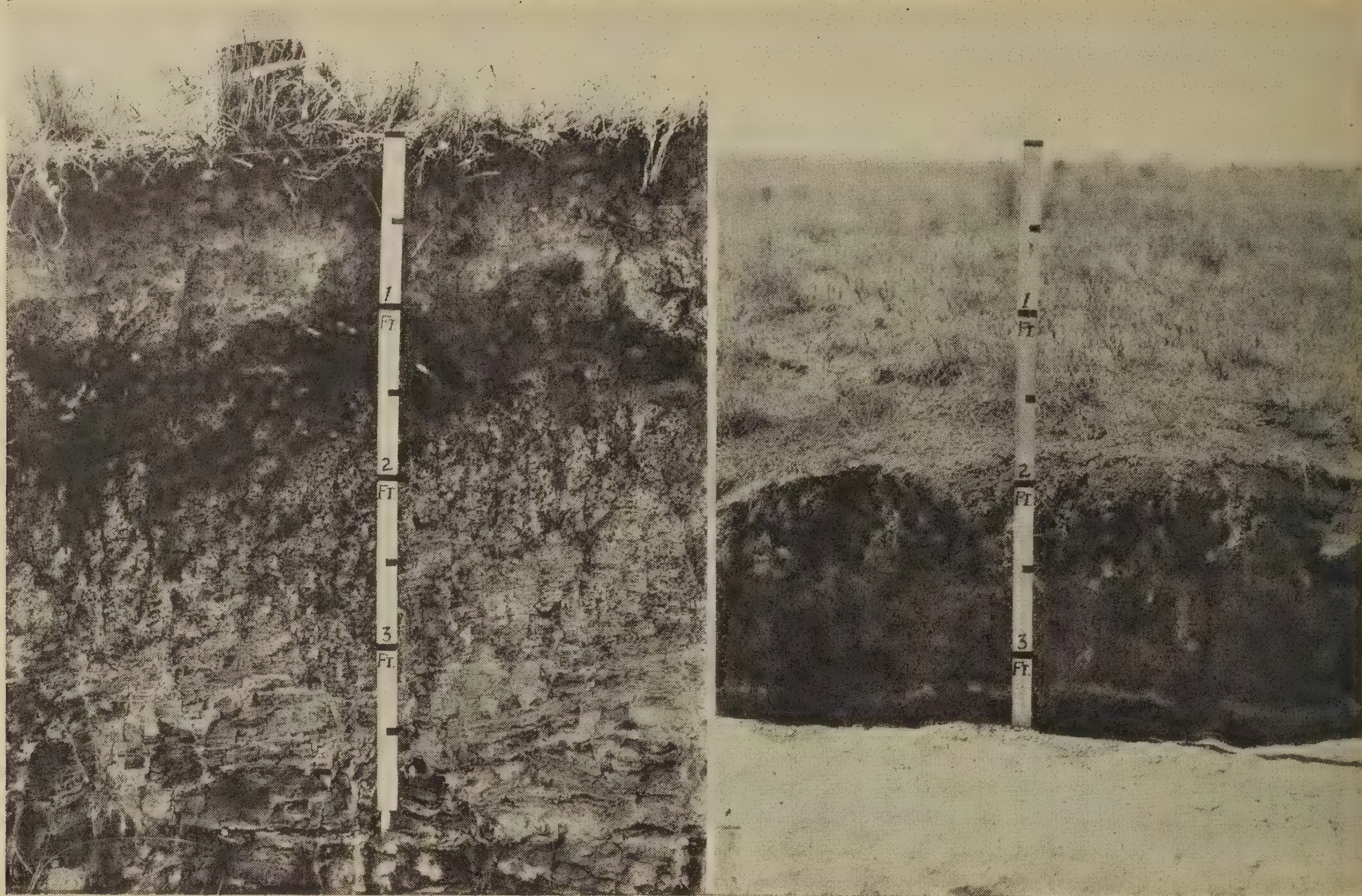
[6] Kramer, J., and Weaver, J. E. Relative efficiency of roots and tops of plants in protecting the soil from erosion. Nebr. Univ. Cons. Dept. Bull. 12. Lincoln, Nebr. 94 pages. 1936.

[7] Weaver, J. E., and Harmon, George W. Quantity of living plant materials in relation to run-off and soil erosion. Nebr. Univ. Cons. Dept. Bull. 8. Lincoln, Nebr. 53 pages. 1935.

[8] Booth, William E. The relation of plant communitiesto soil erosion in Cleveland County, Okla. Unpub. thesis, Department of Botany, University of Oklahoma. Norman, Okla. 1932.

Vegetation provides the natural home for wildlife species. On the margin of a forest community is found an intermixture of trees, shrubs, and open grassland, which provides ideal environment for some game species.





While using natural vegetation as the indicator of environment, the ecologist must consider the changes wrought by man's disturbance. Comparison of the above soil profiles from tallgrass prairie in Oklahoma shows the removal of approximately 2 feet of topsoil since disturbance of original grassland. The measuring stick is in the same relative position in each picture.

Carya) and Oak-Bluestem (*Quercus-Andropogon*) communities; while the least erosion was found in Bluestem-Dropseed (*Andropogon-Sporobolus*) communities.

Vegetation and Wildlife

Wildlife conservation, along with soil conservation, must deal with the vegetative cover of the earth. This cover is the home of wildlife species. It is both their shelter and their food.

Each kind of animal has its own special requirements and lives in the particular type of vegetation which most nearly suits these needs. Within its range, the average population of a species rises and falls as the condition and quality of the vegetative cover does or does not favor its own particular requirements.

If man undertakes to manage and control wildlife populations, it is plain that he must work through vegetation. The plant species, either separately or in their natural associations are the materials which he must use. *These species and associations, however, cannot be shifted indiscriminately about the face of the earth. Each must be manipulated in its own natural environment.* The natural vegetative pattern, therefore, constitutes the framework for the wildlife manager's program and tells him what are the possibilities in any particular area.

Significance of Original Vegetation

The basis of an understanding of the natural vegetation is a picture of the vegetation which occupied the area before the white man's activities so disturbed it as to initiate the processes of erosion and deplete wildlife populations.

Against this picture of original vegetation, present conditions may be viewed and interpreted. By comparing the present pattern with the original, the conservationist may see the damage to the vegetative cover that has led to soil and wildlife losses. He also may see the trends of plant succession initiated by the disturbance, and may discern potential forces of correction within the vegetative cover itself. Having inter

preted the results of man's activities to date, he then is in a position to see how even minor changes in the treatment of the natural vegetation will frequently result in material improvement in cover, to the benefit of both soil and wildlife. Likewise, he may see the weaknesses of the natural plant communities of his particular area and be better able to judge where strengthening by artificial means is necessary.

As pointed out at the beginning, an understanding of the environmental adaptations and indicator values of native species and communities provides a guide for planting practices. Not the least important, it discloses the limitations imposed by the environment upon the use of introduced or exotic vegetation in the conservation program.

In using the original vegetative pattern as an indicator of environmental conditions with which he has to work, the conservationist must not fail to consider the changes wrought by man's activities by and since the disturbance of the original cover. The topsoil of a particular site may now be partially or entirely removed, or its store of plant nutrients depleted. The minor details of topography may be modified. Surface moisture concentration and ground water table may be altered. Local atmospheric humidity may be different. But, whatever these changes in local edaphic conditions, it is certain that the climate has not been materially changed, and the same general type of vegetation which originally developed under that climate must be depended upon to provide the special combination of species which will meet the local conditions of the site. What that special combination of species may be can be determined by observing the particular variations of the climatic type which occupy similar local situations under natural conditions (not failing to recognize weed communities as a part of that type); or, possibly, only by removing all interference from natural succession and permitting the native type of vegetation to cope with the situation as only it can. If exotic species are to be used successfully, they must be species with the same environmental requirements as of the native species which otherwise would occupy the site.

Under all circumstances, it is important that the person who undertakes to manage vegetation to serve the purposes of soil conservation and wildlife production knows the type of natural vegetation which originally occupied the site. One of the first steps, therefore, in planning such a conservation program is to map and analyze the original vegetation of the area under consideration.

At least in the newer agricultural sections of the country, where relicts of the original plant communities are extant and the original pattern has not been too completely obscured by secondary succession, this is a relatively simple matter, once it is determined what types of natural vegetation originally were represented in the region and their basic ecological relationships are understood.

The methods used by the authors in a reconnaissance of the original natural vegetation of the Central Great Plains Region will be explained in another article.

HEDGES AND WINDBREAKS FOR SALINE LAND

Irrigated land that has a high water table is likely to suffer from alkalinity. On such lands hedges and windbreaks are important. Of the shrubs and small trees suitable for this purpose the Russian-olive (*Elaeagnus*) is one of the species that can best endure the presence of a moderate quantity of salts. Golden willow also is worthy of a test in regions having severe winters. In the Southwest, the pomegranate and species of tamarisk, decidedly salt-tolerant plants, are excellent for hedges. One species of tamarisk is hardy as far north as central-western Nevada. Some larger growing saltbushes are very tolerant of salinity and also make sturdy hedges.

KENYA NATIVE FARMER PROTECTS TREES

In the North Kavirondo and Kikuyu Provinces of Kenya, East Africa, the native farmer, when cultivating his land, is careful not to destroy tree vegetation. Any trees in the area are either coppiced or pollarded, this being done to ensure that the trees are not killed. After weeding the crops, the weeds are piled up around the trees, thus assisting them to recover from the removal of their tops. This must to some extent also check surface wash on the plot.

HALTING DRIFTING SANDS

Diplotaxis tenuifolia, a yellow-flowered, mustardlike Cruciferous plant, known in the pastoral districts of South Australia as Teetulpa, is being used in that country for stabilizing drift sand. This plant is considered advantageous on low-lying patches on which water accumulates and remains for a time before evaporating. Sheep will eat Teetulpa.

CONTROL AND USE OF LITTLE WATERS IN FRANCE

(*Continued from p. 125*)

to the main ditch, the fish pond is cleaned at the same time, then the sluice gate is closed. Rain water gathers in the basin and, if rains are plentiful, 99 days will be enough to fill the pond. The depth of the ponds, therefore, is in direct relation to the hygrometric state of the atmosphere. It does not exceed 5 feet in the central part; in the fish pond it reaches about 10 feet. But the depth of the water is subject to great fluctuations and long periods of droughts constitute a great danger.

Fauna and flora of the pond are extremely rich. Fish find abundant food. One puts in mainly carp, some pike, and some perch. The ponds generally remain under water for 2 years and are cultivated in the third year. The fish are taken out at the beginning of the winter in order that the first frost may destroy the aquatic plants which form good fertilizer for the cultivated crop. If not destroyed, these aquatic plants hamper cultivation. The present surface of the ponds in the Dombes is approximately 25,000 acres.

There are in France many other regions containing a considerable number of ponds but none of them exceed the great surface of those in the Dombes. Most of these ponds were created in the Middle Ages by religious communities and by feudal seigniors, on their large estates to provide food for the great number of fast days (140 out of 365) imposed by ecclesiastical laws. At the present moment one can estimate the productive extent of lakes and ponds in France at 325,000 acres.

While surface water is frequently used for power, irrigation, and fish raising, underground water is rarely utilized directly. One such example exists in the Cran, a stony plain east of the river Arles and the Rhone. Most of the land was covered with lean pastures for cattle. The surface of this plain is separated by an impermeable layer of soil, 30 feet thick, from a heavy stream of clear water. The stream is supposed to be the old bed of the Durance which now joins the river Rhone much more to the north, at Avignon. This water is brought to the surface at certain points by drilling wells and installing pumping stations. After the land was cleared of stones and irrigated, fruit trees, grazing land, and vegetables replaced the poor grass of the former desert lands of the Cran.

DAYTON MEETING CONSIDERS AGRONOMIC PRACTICES

(*Continued from p. 116*)

Kennard, of the regional office. "It is not sufficient that we help the farmer work out a farming program that will control soil erosion. We must go further and demonstrate that farmers can afford to follow certain methods which we ask them to adopt on the demonstration farms."

These methods include in some localities longer crop rotations, contour cultivation, strip cropping, contour furrows in pastures, woodland management and reforestation of seriously eroded areas, more legumes, encouragement of wildlife, pasture management, and the control of active washing in gullies, said Kennard.

Such methods and practices, he explained, will control sheet erosion, which is common on sloping land and which often leads to gullying. The soil conservationists determine by scientific methods which crops can be grown safely on every acre of the demonstration farm. The land then is put to such use, often requiring changes in the farmer's type of farming. These changes—whether they could and should be made, and if so, how—were questions discussed by those attending the meetings in regional headquarters.

T. V. A. PLANTS TREES TO PROTECT NORRIS DAM

(*Contiuued from p. 115*)

The water from the eroding area is collected by diversion ditches and carried to the control gully in which permanent dams have been constructed. The remaining gullies have been plowed in, matted, mulched, and seeded. Seedlings planted along contour furrows in these 52 acres included 125,000 black locust, 7,800 shortleaf pine, and 17,000 black walnut.

Roadside erosion control involves matting and seeding of cut slopes, planting with vines and trees.

The Authority's comprehensive program seeks to anticipate the silting threat which has arisen in the case of other large dams, and is moving to control excessive erosion by engineering and vegetative measures on the watershed.

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

MIGRATION AND ECONOMIC OPPORTUNITY. By Carter Goodrich and Others. Philadelphia. 1936.

"If a farmer planting corn on a steep hillside in the Appalachians or plowing the windswept Great Plains is thereby wasting the Nation's soil resources, should he not be induced to move for his country's sake, even if not for his own? Or if the establishment of a family on an isolated farmstead in the Wisconsin woods is likely to cost State and county far more in school and road maintenance than the farm will ever pay in taxes, and perhaps more than it will ever produce in crops, should not such settlement be checked to reduce the burden on the taxpayer?" Herein lies the central theme in this study of the relationship between migration and economic opportunity. Where should the people be, and how should they best get there? By what ways and means may migration go forward with the least havoc in community dislocation and human uprooting?

In this report of the Study of Population Redistribution, organized in 1934 under the auspices of the Industrial Research Department of the Wharton School of Finance and Commerce of the University of Pennsylvania, the theme is developed by means of consideration of three bodies of experience: (1) The unguided migrations, since settlement of the continent, which have been characteristic of the American people; (2) certain attempts at controlled placement of population in foreign countries; and (3) recent projects of population redistribution in the United States under pressure of emergency.

In an opening discussion on regional contrasts in economic levels, an attempt is made to determine which areas have fared better than others, and to isolate for further study certain regions in which the problem of population placement is particularly acute. Outstanding regional studies included in this part of the book are the Southern Appalachian Coal Plateau, by Tryon and Allin; the Great Plains, by Thornthwaite; and the Cut-over Regions of the Great Lakes States, by Allin. These three studies might well supplement Odum's Southern Regions, a review of which was published in the August 1936 issue of Soil Conservation, in comparison of the economic status of various parts of the country in prosperity and depression. In a fourth regional study, the Old Cotton Belt, Rupert B. Vance discusses the pressure of increasing population under diminishing utilization of resources, the boll-weevil invasion, and the loss of world cotton markets.

The analysis of the Southern Appalachian Plateaus is extensive and contains considerable data concerning population surplus, the agricultural, mineral, and forest resources of the region, and survey results which point to conditions favoring further increase in manufactures for the relief of unemployment and low standards of living in the coal plateaus. As to agriculture in this region the authors state that ". . . the proportion of land with slope too steep for continuous cultivation is very high. For these reasons good farm land is scanty and most land in farms is marginal or submarginal for commercial agriculture. . . . If the depression has had any effect on the land itself, it is doubtless one of accelerating the already rapid rate of erosion. . . . In view of the topography of the region this is not at all surprising. A sample study in Knott County, Ky., 'showed that in 1930 only 15 percent of the crop land and less than 1 percent of the open pasture land had a slope of 10 percent or less. . . . Approximately 77 percent of the crop land . . . had a slope of 40 percent or more.' Such slopes cannot be plowed without serious soil wastage, and the present farm population cannot maintain even the existing low levels of living without cultivating them. Thus, a progressive lowering of living standards through soil erosion seems inevitable unless the pressure of population upon the land is relieved."

Since it is inconceivable that an increase in manufacturing can provide adequate relief of the obvious pressure of population on farm, forest, and mine, the Southern Appalachian plateaus emerge from the analysis as a region from which a spontaneous migration is to be expected and from which it should be encouraged. "The main reliance in encouraging migration must therefore be placed on facilitating the spontaneous tendency. . . . If the standards of education and transport in the mountains can be raised to the level enjoyed by the rest of the country, migration should flow with a large measure of response to economic opportunity." The authors estimate that at least 340,000 people should migrate, spontaneously, from the Southern Appalachian coal plateaus.

In his study of the Great Plains, Dr. Thornthwaite has attacked the subject of migration from the only possible viewpoint—that of climate, soil, and vegetation. Concluding a comprehensive description of the physiography of the region, he states that "vegetation, soil, and climate combine to form a habitat which has imposed certain definite restraints on its exploitation. The area was long considered to be incapable of agricultural development. Gradually, however, farmers began to displace cattlemen, and by experimentation attempted to establish a crop system. Even after 40 years of trial, a permanently successful system has not been evolved. The misguided agricultural expansion, especially since 1920, has left a large number of families stranded." Proceeding with a history of settlement in the Great Plains, from the time of roving buffalo herds and nomadic Indians, through the Gold Rush, cattle raising, homestead legislation which encouraged the westward extension of agriculture into a region never intended for such exploitation, the dry farming period, and agricultural mechanization, with the overexpansion brought finally to a disastrous conclusion by one of the recurring periods of drought, he thus introduces his intensive analysis of the climates of the region.

A new map series by Dr. Thornthwaite shows the climates of the Great Plains throughout the period 1910–34, the climatic years and climatic gradients. In explanation of these maps he states that "the moisture types shift in an unpredictable manner with no recognizable pattern of change. Although it is impossible at present to forecast the moisture conditions a season in advance, methods analogous to those of the actuary make it possible to estimate the probability of recurrence of given climatic conditions." Thus, these maps form an important basis for estimating the feasibility of continued agriculture in various parts of the region.

Dr. Thornthwaite considers further the intensity and areal extent of damage to land from wind erosion from the standpoint of average wind velocity and movement as determined in a reconnaissance survey by the Soil Conservation Service. Accompanying maps show the relationship between various degrees of wind erosion and wind velocities. "Sixty-five percent of the total area of the Great Plains has been damaged by wind erosion; 15 percent is severely damaged, and the economic value of more than 1 percent is de stroyed. Including the effects of other forms of erosion, more than 98 percent of the land in the area has suffered from erosion . . . there are no other semiarid areas on the earth where so much of the surface has been denuded. . . ."

In his discussion of population prospects in the Great Plains, Dr. Thornthwaite considers ways and means—irrigation, redistribution of the land and equalization of holdings, and subsistence homesteads—for industrial development of the Great Plains as opposed to the migration of some 390,000 people. "The most rapid solution apparent", he states, "would be a gigantic land retirement program in which private lands would be returned to public ownership. These lands could then be consolidated into districts and leased under supervision for the purposes to which they are best suited, ordinarily grazing."

Bushrod W. Allin summarizes the problems of the cut-over region of the Great Lakes States as follows: "The distress of the cut-over region has been aggravated recently by depression phenomena which we may still hope are temporary. Outstanding among the temporary difficulties are (1) the acute unemployment at the mines because of reduced demand for iron and copper, and (2) the recent occupancy of poor land by thousands of depression migrants from industrial areas. More important, however, from the standpoint of long-range policies, are the problems which confronted the region before the depression and which will remain for solution after industrial recovery. Rural poverty, isolated settlement on poor land, and excessive costs of local government were characteristic of most of the area prior to 1929, while at the same time employment in mining and woodworking industries was steadily declining." As solution to the problems it is suggested that any constructive program for improvement must have as its central objective the establishment of a permanent forest-farm economy, supplemented by recreational development. To establish a balance between population and resources, it would seem from data presented that less emigration is needed in this region than in the others discussed in the book. As stated by the author "long-range migration policies for the cut-over region of the Great Lakes States concern chiefly the prevention of unwise settlement and the correction of past mistakes by a redistribution within the area of settlers already there."

In a final chapter, Toward a Migration Policy, Carter Goodrich, director of the study, considers ways and means for economic stabilization of the country as suggested by data from research, analyses of advantages and imperfections of unguided migration, and examinations of certain methods of countries abroad and at home by which attempts have been made to guide and control the placement of population. Herein he presents an argument for Federal aid for education in the less favored areas as the most important consideration in the economics of migration.

The appendix contains tabular information concerning wheat production in western Kansas, location of manufactures, and a memorandum on the selection of manufacturing areas for the housing program. Illustrations throughout.

ENVIRONMENT AND LIFE IN THE GREAT PLAINS. By Frederic E. Clements and Ralph W. Chaney. Washington. 1936

This treatise opens with a brief discussion of Paleozoic and Mesozoic vegetational changes and proceeds to a more detailed account of earth changes during the Cenozoic era as related to the development of vegetation in the continent of North America, particularly the Great Plains region. Emphasis is placed upon climatic changes and fossil evidence of plant life as afforded by the flora of the Don beds—the basal member of the Toronto formation as exposed near Toronto in 1900 and 1907. Arriving at the period of Plains settlement by the white man, the authors launch a rather extensive discussion of transformation under cultivation. It is the story of the conquest of the grasslands, with plant species, one after the other, fading into extinction under prevalent overgrazing; with decimation of game birds and animals and resulting increase in rodents until in many localities this condition assumed the proportions of a pest; and with advance and retreat of settlement as related to loss of native cover plants and drought.

The gist of the treatise is a discussion of the problems of readjusted utilization for the Great Plains, with particular emphasis upon the climatic cycle as the master clue to the manifold interactions of environment and life, whether these take place in nature or under the direct or indirect influence of man. In this connection the authors state authoritatively that "land classification, utilization, and conservation all rest squarely upon the basic principle of cycles, and no permanent and scientific system of production is possible without taking it into full account."

In regard to the need for ecological synthesis, emphasis is placed upon the importance of a detailed survey of every farm and ranch to determine the best use of its various parts. Such detailed survey must, of necessity, demand the fitting into a unified system of crop, grass, and forest communities, and likewise the placing of emphasis where climate and soil indicate it belongs. "Fortunately", the authors state in conclusion, "times of stress provide the very pressure needed, as well as the agencies to guide the response to it, and it now seems probable that cooperation will be set forward more in the present generation than in the full century since the settlement of the West began. However desirable it may seem that this and other social functions make a natural growth, it is evident that the nation-wide experiment of having the first steps directed by the Soil Conservation Service, Forest Service, and Division of Grazing, in their various jurisdictions, promises the only adequate solution of this crucial problem in social progress. To the ecologist, who recognizes that society as a complex organism is certain to evolve in harmony with its environment, it is of critical importance that the environment be so fashioned as to call forth progress and not retrogression."

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A PANORAMIC VIEW OF STRIP CROPPING

More than 800,000 acres, in practically every State of the Union, have been strip-cropped in demonstration areas of the Soil Conservation Service.

On these acres the regular farm crops are being grown in long, relatively narrow strips or bands, across the slopes and approximately on the contours.

This stands today as the leading vegetative method of controlling soil erosion. Its practical effect is to "shorten" the slope—an advantage over putting the entire slope in one crop.

Of the many combinations which have been tried, the best appears to be an alternation of row crops with close-growing crops—small grains, legumes, and other hays.

It has been found that the first few feet of a close-growing strip will strain out sediment, will act as a spreader, will prevent concentration of water, will induce infiltration, and will lower run-off.

Rotation is an essential feature of any good strip cropping system.

Strip cropping costs little, adapts readily to the farmer's general cropping plan.

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

Featuring—

Contour Furrowing

JANUARY **1937**

The photograph from which this cover was drawn is reproduced on page 151.

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WELLINGTON BRINK — EDITOR

SOIL CONSERVATION

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ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

An Introduction to This Issue

WINTER is a good time for farmers inside and outside the 153 erosion-control demonstration projects to think about pasture improvement and range management.

Contour furrowing has proved effective in conserving moisture, reestablishing vegetation and holding soils in the droughty, windy West, and in increasing plant growth and slowing run-off in the rainy East.

Mr. Newport's article discusses contour furrowing with particular reference to High Plains range lands. Page 139.

Dr. Dahl's article treats of the practice as applied to the Corn Belt. Page 141.

Mr. Brown contributes some very practical information on four types of furrows which are proving their worth in Region 1. Page 143.

While there is yet much to be learned about this instrument of erosion-control, it has already demonstrated its simplicity, its economy, its flexibility, and its efficiency under widely varied conditions.

There are some 800,000,000 acres in this country devoted to grazing. That is approximately 40 percent of the whole United States—more than twice the area in cultivation. There are perhaps 200,000,000 other acres—cut-over land and forest—used partly for grazing. The totals serve to open a window on a broad panorama of opportunity—an opportunity made more important by the present poor condition of so many pastures.

Mr. Semple gives a swift review of contour furrowing as it occurs in each of six regions. Page 134.

Reports from the field say that by encouraging farmers to construct contour furrows, the Soil Conservation Service has stimulated their interest in the entire program of pasture improvement. Many times farmers who have creased one part of their farms with furrows have later asked that contour lines be run on the remainder of their pastures. They have found that small furrows spaced at short intervals interfere neither with the mowing of weeds nor with the moving of farm implements across the fields. They have used their own tools, have not been put to large expense.

The back cover illustrates the favored type of construction.

West of the Mississippi, where moisture is a limiting factor in production, contour furrowing of pasture and range lands has proceeded more rapidly than elsewhere. Farther east, it has proved its worth in slowing the pace of running water; here, instead of acting to keep good soil out of the air, it serves to keep good soil out of the streams.

PROJECTS are eager to demonstrate to the farmer how he may conserve his soil at least expense. In every region short-cuts and cost-reductions are being effected through intelligent planning, through the substitution of vegetation for elaborate structures wherever feasible, through the adaptation of equipment already at hand, and through making use of the information accruing from both operations and research. News of such progress will be found in these pages from month to month.

Dr. Buie starts off the series with a brief account of economies being wrought in Region 2. Page 151.

The Editor.

Following Contour Furrows across the United States

By A. T. Semple[1]

IN REGION 1, as elsewhere, the average farm pasture has too little cover to hold the torrential summer rains, with the result that there is frequently a shortage of moisture during midsummer. Contour furrows have considerable value here as a means of holding the rainfall until it can be absorbed by the soil. It has been observed that rainfall penetrates 6 to 18 inches deeper on land that is furrowed. By using equipment which the farmers have, and by plowing small furrows close together, the work can be done very cheaply and as much as 80 percent of heavy rains can be held.

In one instance such conservation of moisture provided sufficient pasturage for the farm stock throughout July. It was evident that without the furrows there would have been no pasturage worthy of the name. And yet, a common mistake is to keep stock on untreated pastures, where they tramp out and eat into the ground the little vegetation that is there. Such a practice usually accelerates erosion and decreases still further the capacity of the soil to sponge up water.

In making the furrows, the plow is "jumped" out of the ground at distances of 15 to 50 feet, leaving blocks 3 to 6 feet long to stop the drainage if the grooves are not exactly on the contour. With a little planning, it is believed that most farmers will be able to put in such furrows without an instrument to establish contour lines.

When soil moisture conditions are optimum for plowing, single furrows are generally sufficient. When the soil is so dry that the furrow slice crumbles, leaving breaks through which water will flow, a second furrow slice laid on the first will help to fill the breaks. It is considered a good practice to line, fertilize, disc, seed,

[1] Senior agronomist, Soil Conservation Service, Washington, D. C.

Typical pasture being contour furrowed in Marshall County, W. Va., where field slopes commonly vary from 15 to 30 percent. There has been severe erosion in the pasture just beyond the one being treated.

and roll or cultipack these furrows. Furthermore, it is desirable to keep stock off of such pastures until the disturbed soil is well covered with vegetation. At the close of October 1936, 2,067 acres of contour furrows had been completed in Region 1.

South and Southeast

In Region 2, Mississippi leads in this practice. Contour furrowing of pastures has been employed satisfactorily for several years at the coastal plain experiment station, McNeil.

Contour furrows on project areas are spaced from 10 to 30 feet apart horizontally. No definite vertical interval is used. The slopes on which contour furrows are constructed range from 4 to 15 percent. Construction usually is done with mule-drawn equipment. The completed furrows have a base width of about 6 feet and a height of from 6 to 12 inches. Such work may more properly be called contour ridging, since several furrows are thrown together. Small gullies are crossed, but no attempt is made to cross large gullies. The ends of the furrows are turned slightly up-grade as large gullies are approached to prevent the delivery of water into the latter. Generally, barriers are formed by throwing a few shovels of soil into the furrow at intervals of approximately 50 feet. Where small gullies are crossed sufficient filling is done to protect the ridges from breaking at the gullies.

Ordinarily, where contour ridges are constructed on land already covered with sod, the entire strip broken is revegetated naturally by the end of the first growing season afterward.

Low Cost Recorded

The following information is taken from the report of the Port Gibson project which is located on the rich loessial soils of Claiborne and Jefferson Counties. On account of the very broken topography, much of the land is too steep for clean cultivation.

Contour ridges are constructed with a 10-inch Kelly or Oliver plow making three rounds or six furrows with a three-mule team. The furrow on the upper side of the contour is then cleaned out with a home-made "V-drag", the wing being only 3 feet long so as not to open the ditch too wide. Hand labor is then used to patch up weak places and to turn up the ends. This gives a ridge approximately 6 feet wide at the base and 10 inches high. Contours are run from 12 to 30 feet apart depending on the slope. The total cost of ridge construction averages around $2 per acre. This includes man labor and mule labor.

Disciplining a Creek

Such ridges have had a very noticeable effect on the overflow of bottom land. Before the work began, Baker's Creek would be overflowed as much as 4 feet after 3 or 4 inches of rainfall. During the winter of 1935–36, approximately 1,000 acres of pasture lands were contoured, all of which was near the head waters of the creek. Since this work was done, Baker's

A badly overgrazed and drought-depleted pasture in western Kansas, as it appeared April 24, 1936. Contour furrows about 10 feet apart were blocked from ridge to ridge at intervals of about 50 feet. This, of course, involved more hand labor than can ordinarily be justified.

Creek has not overflowed nor has the water been within 1½ feet of the top of the bank.

The effect on the growth of grasses during the hot, dry summer has been very noticeable. A strip from 10 to 15 feet wide along each ridge has stayed green all summer, whereas in the spaces midway between the ridges, the grass and clover has dried up and turned brown. The cattle grazed entirely on these green strips.

Most Objections Unfounded

Many objections, most of them imaginary, have been brought forward against contouring. "Can't be mowed": We find no trouble mowing contour ridges 6 feet wide and 10 inches high. "Destruction of vegetation": We find that by reseeding these 6-foot strips with quick-growing and permanent grasses the damage is soon overcome. The loosening of the soil and the holding of extra moisture will grow a new sod within 3 to 5 months.

Experience in Southwest

Although considerable contour furrowing has been done on range land in Region 8, this work is recent and results are not always evident.

Most of the furrows are of the double-ditch type and continuous, such as could be made by going across a field with a turning plow, then coming back, throwing the sod from the second furrow against that of the first, with a ditch left above and below the ridge. They are variously spaced, usually at about a 6-inch vertical interval.

On one project these furrows broke at frequent intervals, the result being an excellent water-spreading system. In general, however, the heavy rains of short duration caused the furrows to break at low places where in some instances serious gullying resulted.

Scattered Crescents

On one area where it was necessary to use hand labor, crescent-shaped trenches, shovel width, 6 inches deep and from 8 to 20 feet long, were dug, the soil being thrown into a ridge below the furrow. These crescent redoubts were staggered down the slope. They were particularly effective along, but not crossing, shallow drainageways and on steep hillsides. It was not necessary to run levels and to stake lines for this work, thus eliminating engineering costs. Native vegetation as well as planted seeds came into

the crescents in great abundance, and the water that could not be held by the trenches and banks spread downhill slowly with no erosive effects.

The Plow Takes a Hop

Another type of furrow that may replace much of the other work is being tried. This is a small discontinuous furrow that can be made with a 10-inch turning plow and a team, or other similar equipment. The plow is run approximately on the contour and is lifted out of the ground every 8 to 10 yards, leaving an unplowed gap of 2 or 3 feet. The sod is thrown up or down slope, depending on the direction of travel, and the furrows are from 8 to 15 feet apart on most range land. These can be made in this country for about 50 cents per acre and seem to be the most practicable and beneficial.

When rainfall is 14 inches or over contour furrows are worth while in this region. This is especially true where there is a grass sod.

In Region 9 contour furrowing in native grass pastures was started this year. The drought has been so severe that practically no data are available to show results. Emphasis is being placed on shallow furrows, closely spaced to provide adequate water-holding capacity and satisfactory distribution of the water, the reason being that the lateral movement of water in the soil is slight. However, many types of furrows are being tried out.

The implements being used are the three-row lister with the middle lister removed, the road plow, the regular turning plow, the two-way turning plow, a modified contour-furrowing machine developed at Mankato, Kans., and the small blade or terracer.

Where the sod is thick, and the soil is of heavy texture, the contour furrow-slicing machine does nicely. On light soils, rocky soils, and areas with limited sod, the machine will not work.

Three-Row Lister Adapted

On large acreages where a minimum cost of contour furrowing is essential, the three-row lister with the middle lister taken out is very practical and economical.

For demonstration and practical purposes, the two-way turning plow performs well. It is practical in that very little sod is disturbed and most farmers have turning plows, which can be operated with either horses or tractor.

Ridge growth of Russian thistles 2 months later. These, together with the larger storage of moisture in the soil, prepare the way for native grass and sweet clover.

Some of the earlier contour furrowing, done under very adverse soil and moisture conditions, cost as high as $1.88 per acre. More recent work, performed under more favorable conditions, cost as low as 25 cents per acre.

Making Use of Bermuda

In Region 7 success in establishing small chunks of Bermuda sod and small sprigs of Bermuda rhizomes on well-prepared contour ridges about six furrows wide has been remarkable. In the Muskogee-project area of 34,000 acres, over 3,200 acres of weedy, worn-out pasture land and abandoned fields are being brought back to productivity with just about the most perfectly erosion-proof covers imaginable. On slopes varying from 1 to 6 percent the average spacing of the ridges is about 20 feet. The farmers plow the furrows and work them down to make a good seedbed while the Soil Conservation Service surveys for the contour lines and does the planting with hand labor. Under favorable conditions, with large pastures and short distances to haul the sod, planting costs have been as low as $1 per acre with labor at 22 cents per hour.

Commonly the ridges are covered the first year by spacing the sod or sprigs in rows about 4 feet apart, one on either side of each ridge. The agreements provide that the farmers will plow two furrows around each ridge each year, until all the space between has been turned. Working the furrows down after plowing helps to smooth out the shoulder left by the plow and makes mowing easier. The ground must be plowed and worked well and the weeds kept down in order that the Bermuda grass may spread satisfactorily. A strip of ground shaded by weeds, shrubs, or trees serves as a barrier to the spread of Bermuda grass. Regions 2 and 4 are having similar success in planting Bermuda on contour ridges.

Texas, Arkansas, Louisiana

Region 4 has followed the plan of building contour ridges which consist of four furrows thrown together. Once settled, these have an effective height of 4 to 5 inches.

On the steeper slopes, the ridges are placed about 12 feet apart, while on the more gentle slopes they may be spaced as far as 25 feet apart. Although any large turning plow may be used for ridge construction, the recommended procedure is to make the first round with a 12-inch turning plow, and the other with a long-winged terracing plow. (For details of contour-ridge construction, members of the Soil Conservation Service are referred to pp. 33 and 34 of the Region 4 agronomy manual.)

In practically every instance contour-ridged pastures have shown a greater infiltration of rainfall when compared with pastures having no ridges, regardless of slope or cover. The infiltration was greatest just above the ridge where water was held. The following is a report of tests made to determine depths of penetration on pastures having contour ridges and in similar pasture areas where there were no ridges.

Moisture penetration tests in pastures (1–5 days after rains)

Location	Soil type	Slope	Rainfall	Moisture penetration contoured	Moisture penetration not contoured
		Percent	*Inches*	*Inches*	*Inches*
Natchitoches, La., 4.	Bowie F. S. L.	4	2	7	4
Do	Kirvin F. S. C.	3	2	13	10
Conway, Ark., 1	Hanceville G. S. L.	A	4	20	20
Do	do	B	4	20	17
Do	do	C	4	14	10
Do	do	D	4	13	6
San Angelo, Tex., 6.	Miles F. S. L.	0. 3–5	16–25	60	37
Do	do	4. 5	16–25	52	26
Do	Abilene S. C. L.	0. 5– . 3	16–25	52	35
Do	Miles F. S. L.	1. 7–1. 5	3	27	9
Do	Abilene S. C. L.	2	4. 57	24	12
Do	do	3	4. 57	19	8

The greatest general increase in growth of desirable vegetation has occurred on the more gentle slopes where the ridges have served as small levees to hold the rainfall on the ground and to spread it between the ridges to allow general absorption. In practically every case, however, regardless of the slope, there has been a pronounced increase of growth in the water channel just above the ridges, on the ridge bed, and immediately below the ridges. This is due, of course, to the water held by the ridge and to the effect of plowing. On the steeper slopes cattle frequently have been observed grazing on, or immediately adjacent to, the contour ridges where the grass was considerably better than on the area between.

Disadvantages of Contour Ridges

While the merits of contour ridges far exceed the disadvantages, there are some definite objections to be considered:

(*a*) Mowing for weed control is difficult. Where sheep are used in combination with cattle, this has not been a serious problem.

(*b*) Weeds make a rapid growth on the ridges.

(*Continued on p. 145*)

A CORDUROY COAT PROTECTS HIGH PLAINS FROM DROUGHT

By Fred C. Newport [1]

An example of pasture contour furrowing near Perryton, Tex., in the spring of 1936. Following three rains, moisture penetration tests showed 14 inches more on this pasture than on an adjoining, untreated pasture.

In the High Plains [2] an effective grass cover is needed to break the ground sweep of the wind and hold the soil in place. Recent years of agricultural expansion destroyed vast areas of native sod. The depression which followed, coupled with severe droughts, frequently resulted in indifferent farming or outright abandonment. The bare, unprotected soil was readily moved by the preying winds. Overgrazing joined with drought and was aided in the erosional process by the abandonment of neighboring fields. Depletion of land, often complete denudation, was the usual result.

But wind and drought and dust are to be more stubbornly opposed. Revegetation is to be encouraged by grazing management and mechanical treatment for maximum moisture utilization. A fundamental objective of the program is the restoration and maintenance of sufficient height and density of vegetative cover to prevent soil erosion.

Saving Each Drop as it Falls

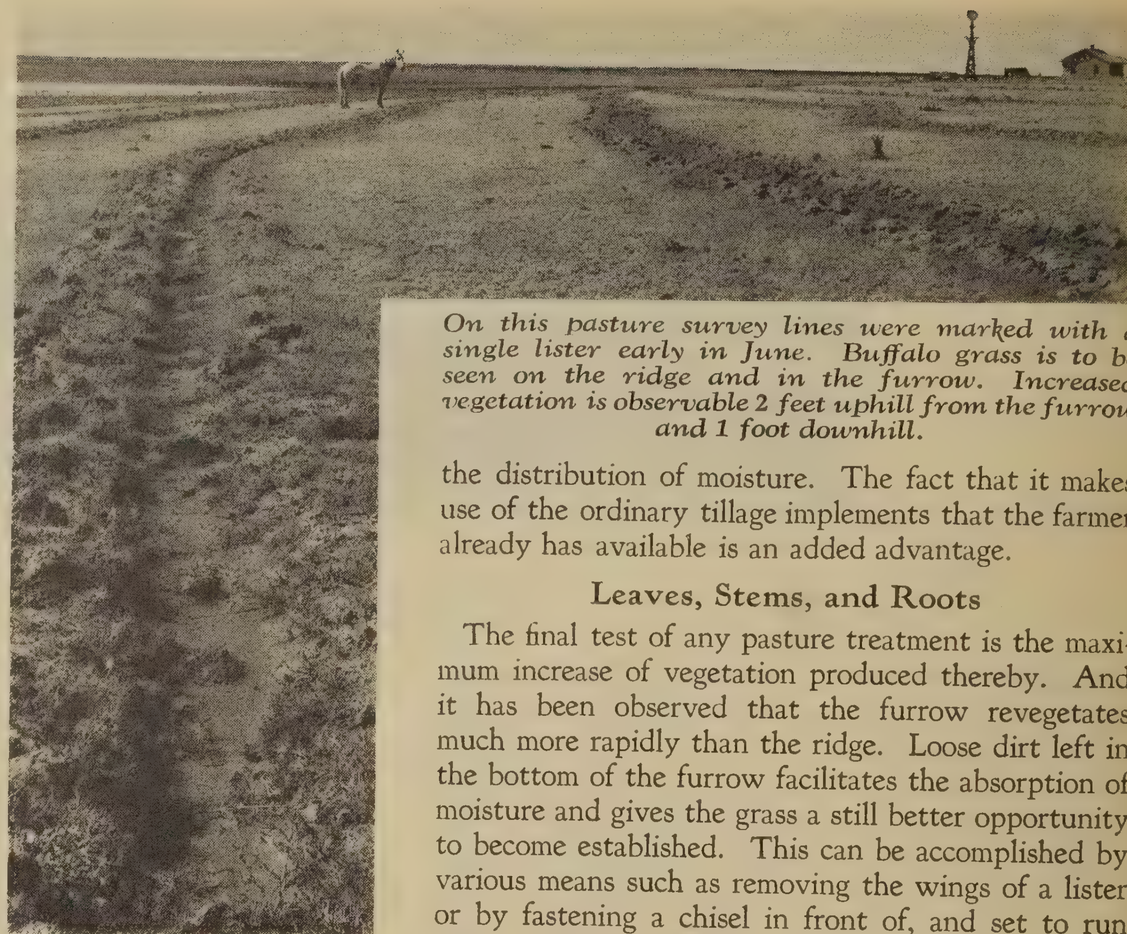
The purpose of mechanical treatment of grasslands is to store and distribute moisture so that it will approximate as nearly as possible the results of natural and sufficient rainfall. The ideal is for each drop of rain to go into the ground where it falls. The mechanical treatment for moisture conservation has as its objective the maintaining of an even and thrifty distribution.

There are many problems involved in determining the most efficient method. Some of the prominent factors are climate, soil, topography, adjacent drainage area, type of vegetation, and the adaptability of farm machinery to the job. The contouring of range land is of three general types: The furrow with the ridge caused by the furrow slice minimized as much as possible; the ridge in combination with the furrow;

Increased vegetative growth as result of different types of furrowing on ranch near Amarillo, Tex. Note the advantage of plowing narrow, shallow furrows on the contour between ridges. Observe the increased vegetation on the upgrade side of the furrows. Technicians determined that areas so treated produced 106 pounds of blue grama and buffalo grass, as compared with 41.6 pounds on untreated areas.

[1] Regional agronomist, Amarillo, Tex.

[2] The November physical progress report showed that 81,542 acres had been contoured in Region 6, embracing parts of Texas, New Mexico, Oklahoma, Kansas, and Colorado.



On this pasture survey lines were marked with a single lister early in June. Buffalo grass is to be seen on the ridge and in the furrow. Increased vegetation is observable 2 feet uphill from the furrow and 1 foot downhill.

and the terrace. The factors just enumerated will largely govern the method or combination of methods to be adopted.

While this work has not been in progress sufficiently long to point to any single method as being the most efficient, there have been enough observations made during the past year to indicate the practicability of each of the several methods under given circumstances. All factors considered, the method that at present appears to have the most universal application on the High Plains where the problem is largely the prevention of surface run-off, is the making of frequent, relatively shallow furrows on the contour, minimizing as much as possible the ridge caused by the furrow slice. This is done by spacing the furrows far enough apart to prevent overlapping. This treatment disturbs a minimum amount of sod and maintains to a maximum degree the distribution of moisture. The fact that it makes use of the ordinary tillage implements that the farmer already has available is an added advantage.

Leaves, Stems, and Roots

The final test of any pasture treatment is the maximum increase of vegetation produced thereby. And it has been observed that the furrow revegetates much more rapidly than the ridge. Loose dirt left in the bottom of the furrow facilitates the absorption of moisture and gives the grass a still better opportunity to become established. This can be accomplished by various means such as removing the wings of a lister or by fastening a chisel in front of, and set to run deeper than, the furrow opener. (Such a device also minimizes dulling and breakage.) A hard, slick furrow bottom has a tendency to "bake" and crack, thus lessening its absorptive power and its opportunity for rapid revegetation.

(*Continued on p. 145*)

Pasture furrowing done with a two-row lister with mold-boards removed and point wings clipped. This arrangement disturbs a minimum amount of vegetation, and loose dirt thrown out along the edges is not sufficient to smother all grass plants. Several clippings of grass were made by the staff at Hereford, Tex., and the acre-yield of hay calculated: On the furrow, 720 pounds; on undisturbed pasture, 720 pounds; between 44-inch furrows, 1,373 pounds. Yield tests on two other pastures gave similar results.

PROGRESS REPORT ON CONTOUR FURROWING IN THE CORN BELT

A walking plow constructed these pasture contour furrows. Where topsoil is deep, furrows like these may be made without exposing subsoil, so difficult to revegetate. On many soils, however, the ridges do become infested with mullein, field sorrel, annual ragweed, and other weeds. On fertile soils, such weeds readily give way to good forage plants.

By Arnold S. Dahl [1]

Reports from Regions 3 and 5 show that 1,097 and 1,175 acres, respectively, have been contour-furrowed in pastures in these regions. This work covers a wide variety of types of furrows and methods of construction. The vertical interval of the furrows varied from 1½ to 4 feet, and the horizontal interval varied from 6 to 70 feet. A large number of the contour furrows have in reality been small level terraces or ridges, and small, shallow furrows placed close together have not been tried extensively in either of these regions.

Numerous types of equipment have been used. Walking plows from 12 to 16 inches in size have been used, also hillside plows, two-bottom plows, terracers and terracing plows. The width of the surface disturbed varied from 1½ to 9 feet when constructed with a plow and 4 to 18 feet when constructed with a blade terracer. Only rarely were single furrows plowed. The depth has varied from 4 to 10 inches.

Dams or checks were placed in many of the furrows at varying distances of 10 to 70 feet. These were constructed by shovels or by pulling the plow out at intervals. These checks were successful in preventing water from running along the furrows where they were not constructed exactly on the contour.

Usually, the furrows were successful in controlling erosion, as very little breaking-over occurred. In one instance 50 percent of a rainfall was lost from a pasture not contour furrowed, while an adjacent furrowed pasture lost no water. Another pasture was plowed around a gully and contour furrowed on only one side. The unfurrowed side was seriously damaged by gullying after a heavy rainfall, while the furrowed side showed no evidence of gullying. Many other projects reported that the furrows held all of the rainfall and controlled erosion successfully.

Penetration Measured

A few determinations of the depth of penetration of moisture in the furrows were made. These showed

[1] Agronomist, Soil Conservation Service, Washington, D. C.

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that the moisture penetrated 3 to 4 inches in the furrow interval as compared with 18 to 24 inches in the furrow, and 16 and 18 inches just below the furrow. Data were reported by R. F. Copple at the annual meeting of the American Society of Agronomy, in Washington, November 17–20, on the penetration of moisture as a result of furrowing at Zanesville, Ohio. Soil-moisture determinations were made of samples of soil taken from 0–6, 6–12, 12–18, and 18–24 inch depths. These determinations showed that the soil was dry below the 12-inch depth in the furrow intervals. The moisture penetrated to the 24-inch level under the furrow ridge and below that level under the furrow bottom. The first 6 inches under the furrow ridge was as dry as the topsoil in the furrow intervals, but the moisture content increased with depth of soil until the 18-inch level was reached. This indicates that there was some lateral movement of water from the furrow. This additional moisture in the soil was sufficient to support a decided increase in the amount of forage in the furrow. This moisture would ordinarily have run off, and its conservation is a distinct gain for the vegetation in the pastures.

Mr. Copple reported on the work covering 242 acres on 22 farms in the demonstration project area. The furrows were made with a 14-inch walking plow and the whole pastures were usually limed, fertilized, and seeded with a pasture mixture. The furrow interval was usually 12 feet on a 15-percent slope and 25 feet on an 8-percent slope.

Forage Factor Increased

A study was made of the vegetative composition of the furrows, ridges, and intervals and on adjacent pastures which showed that in the furrows the forage factor was increased from 0.38 to 0.65. The forage factor decreased on the ridges where the vegetation had not fully recovered, which may have been due to the excessive lack of moisture experienced in the summer of 1936. The forage factor was only slightly greater on the contour-furrowed pastures as compared with the untreated pastures, according to the first year's data.

It was pointed out that this study of composition and forage value of the vegetation did not take into consideration the increased yield of forage on the contour-furrowed pastures. Since the pastures were being grazed, it was not possible to obtain actual figures of yields but observation showed that the vegetation was much more vigorous and green in the furrows and the stock preferred to graze this vegetation in preference to the drier vegetation outside of the furrows; the stock, therefore, grazed in the furrows more heavily and the grasses suffered from trampling. In spite of this heavy grazing and trampling the desirable grasses and clovers increased in the contour furrows.

Similar Results Elsewhere

Similar reports came from other projects. At one project, it was reported that the vegetation was 3 to 4 times as heavy on the contour-furrowed pastures as compared with an adjoining unfurrowed area. Only in a few instances did reports indicate that there was no increase in the amount of vegetation in the furrowed areas. Conditions for new seedings were very adverse during the past season due to the prolonged drought. For that reason, great difficulty was experienced in securing a stand on the ridges with the result that many of them grew up to the larger weeds.

Most of the furrows were made so deep that raw subsoil was exposed both in the furrow bottom and on top of the ridges. It is more difficult to obtain a stand of vegetation on such soil. Shallow furrows which do not expose subsoil will revegetate much more quickly and result in increased growth and productivity.

Farmers Appreciate Value

The reaction of farmers to contour furrowing was generally very favorable. Some projects reported that 90 percent of the farmers were in favor of furrowing their pastures. In some projects, the farmers were even more enthusiastic than the results received seemed to justify. They noticed the furrows holding water after rains and the increased vegetation along the furrows and observed the cattle grazing the green and vigorous forage. It was one of the easiest practices to sell to the farmers. Those who have contour-furrows in their pastures want more of them.

It is hoped that some demonstrations can be made of smaller furrows placed close together so that a wider range of conditions may be tested. On some soils it would appear that the ideal contour-furrowed pasture would be one where the ridges and furrows are adjacent to one another so that the surface of the ground represents a corrugated appearance similar to corn rows. It would appear that the furrows should be close enough together for the lateral spread of water in the soil to provide sufficient moisture for vigorous growth of vegetation over the whole pasture. This would vary with the permeability of the soil. The

(*Continued on p. 145*)

SPREADING WATER IN THE EAST

By Grover Brown [1]

Four types of furrows are being advocated in Region 1. They all serve the same main purpose—the obstruction and spreading of the downward flow of water over grassed areas, thus allowing longer time for absorption by the soil. All four types might be used on the same area and in conjunction with each other. Their construction is intended to be simple and yet efficient.

1. Uniform Slopes

This type of contour furrow is the one most commonly used on gently sloping pasture surfaces which are uniform in their topography. Such furrows are among those most easily constructed and require the least amount of engineering exactitude. They should be placed at 1- to 2-foot vertical intervals depending upon soil type, the condition of the turf, the steepness of slope, and the watershed above. When the furrow is 50 feet or less in length a skip of 3 to 10 feet is made to prevent draining of one furrow into another should the furrow not be a true contour and breaks occur.

These furrows may be constructed with the ordinary farm plow and usually, if made when the moisture content of the soil is most ideal for plowing, one furrow will suffice. It is better to distribute the water-holding capacity between a number of small furrows rather than between a few larger ones. Small furrows spaced at 6 to 15 feet, having the same capacity as large furrows at 25 to 50 feet, will be of more benefit to the grass. Short furrows mean less likelihood of damage resulting from slight variations from the contour. This makes the problem more simple for the average farmer.

2. Disposal of Water from Diversion Ditch

A terrace, a diversion ditch, or a diversion terrace is often used to conduct surplus water from cultivated fields. Often such outlets are in an adjoining pasture where the water may be used to great advantage in irrigating. By constructing a number of spreader-like furrows below the outlet, the water coming from the terrace may be distributed over a considerable area of pasture, thus adding moisture which, if trapped by furrows for sufficient time, may be gradually absorbed and applied to plant growth. Furrows such as these are placed on a slight terrace grade, with the longer ones near the top, so that water is carried gently from the beginning of the furrow at the outlet to the opposite end and there allowed to soak into the ground throughout the entire length of the furrow. The top furrow will not, of course, be able to absorb all of the water coming from the diversion ditch. Some of it will spill over to be caught by the succeeding furrows. By having the top furrows longer than those just below, what water is carried to the end of the furrow will run out and gradually spread until it reaches the next longer furrow down the slope where the same process is repeated.

The shorter furrows in this series ought to be more nearly on the true contour than the longer ones. This will tend to place a series of obstructions to the downward flow of the water and if enough of these individual obstructions are placed on the slope, their combined capacity will be sufficient so that little or no run-off water will reach the bottom.

3. Drainage of Spring Areas

In many of our pastures are areas characterized by springs or spouts which may flow intermittently for 8 to 10 months of the year, or continuously, depending upon the amount of rainfall and its distribution. Frequently a narrow strip of 3 or 4 feet in width extends from this spring to the bottom of the slope. This narrow strip receives an overabundance of moisture which often results in a swampy or exceedingly wet area covered with dense, rank vegetation.

By a series of small spreader furrows leading off at terrace grades from this strip, the surplus water may be distributed over an area of 15 to 40 feet in width. This will give additional moisture, often sorely needed, to grass on either side, and provide much more forage than otherwise could be produced.

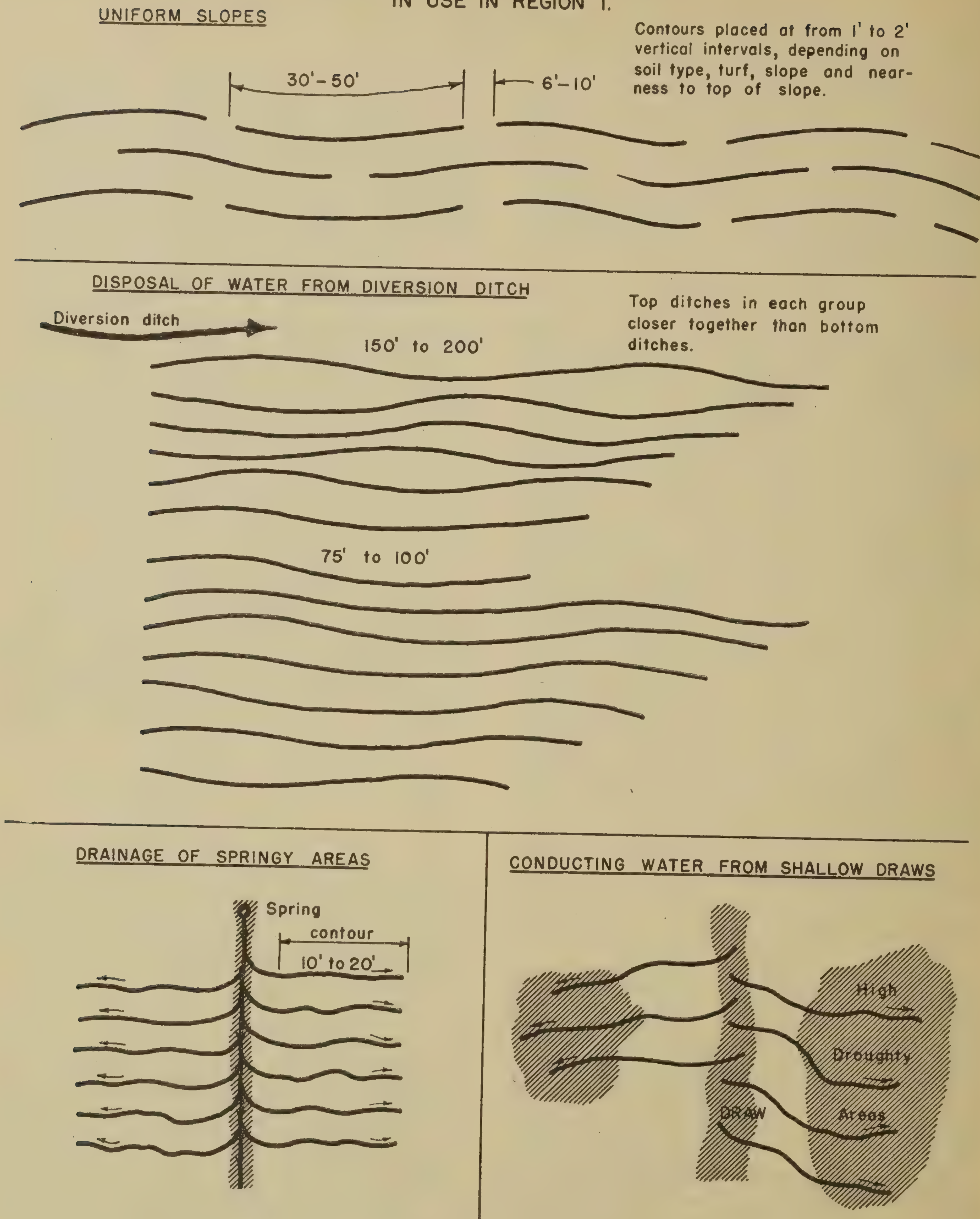
4. Conducting Water from Shallow Draws

In almost any pasture area there are natural low shallow depressions. These are natural water courses, varying in depth from 6 inches to 2 feet, and in width from 1 foot to 6 feet. They are usually covered with dense vegetation or sod, a direct indication of the surplus moisture which they have been able to accumulate. These may be used just as are irrigation ditches, to conduct water to higher, droughty areas on either side. By carrying spreader furrows out of these

(*Continued on p. 145*)

[1] Regional agronomist, Williamsport, Pa.

CONTOUR AND SPREADER FURROWS IN USE IN REGION I.



SPREADING WATER IN THE EAST

(*Continued from p. 143*)

ditches on a terrace grade, they serve to irrigate sections in great need of more moisture. It is neither advisable nor desirable to remove all of the water from this natural draw at any one place. Instead, the water should be diverted a little at a time down the slope, so that it may be utilized over a greater area.

The water naturally flowing down the shallow depressions very seldom does any real damage—this due to the depression's dense covering of sod. Normally it runs off and is wasted; but by this system of furrowing it is converted to the fields on either side of the draw.

By going up the slope and taking the furrow out on a grade varying from 1 to 3 percent for a short distance and then reducing to a more level grade, water may be brought to a point which is considerably higher than the draw directly across from it. Due to the fact that only a little water will be taken out by each spreader furrow, there is little danger of gullying in the furrow itself. Not all the water is taken out by the upper furrows, some of it being left for those at the bottom. By calculating the drainage area above the draw, and the amount of water which may be expected to run down it during hard showers, enough furrows can be constructed so that their combined capacity will utilize all of the surplus water flowing down any particular depression.

Furrowing in Corn Belt

(*Continued from p. 142*)

spacing of the furrows will depend on several factors. They should be so spaced that they will hold the runoff of an ordinary rainfall without being deep enough to expose raw subsoil when they are constructed. This would indicate that on deep soils the furrows may be deeper and spaced farther apart than on shallow soils. Shallow furrows also have an advantage in that the ridges and furrows do not interfere with the use of farm implements, and mowing can be accomplished without difficulty.

If the farmer needs his pasture for current use, it may be possible to construct the furrows farther apart than required for best conservation of soil and water, and additional furrows may be constructed in future years as the older ones become revegetated. However, on pastures with a thin cover and a highly erodible soil, where the construction of widely-spaced furrows may lead to overtopping and formation of gullies, it may be more desirable to construct a complete system of furrows at the top of the slope and leave the lower slopes to be furrowed when the upper slope has become revegetated.

Furrows Across United States

(*Continued from p. 138*)

(*c*) Where ridges are used on steep slopes (C or D), where the water cannot be spread, increased plant growth has been apparent only immediately adjacent to and on the ridges.

(*d*) In fields where practically all of the topsoil has been lost, and where there may be a network of gullies, ridge breaks are common.

Contour ridges may be constructed by the farmer with rapidity and at moderate cost, as compared with some other methods of protection. On an average slope, not severely gullied, a farmer with one team can mark and construct ridges on 2 acres per day. The expense to the Soil Conservation Service has been confined to that of running the lines.

Within the project and camp areas, 40,298 acres have been contour-ridged. Contour ridges have also been put in independently by a large number of farmers outside the areas. This indicates that the practice is effective, practical, and can be duplicated by farmers with their own labor and equipment and at their own expense.

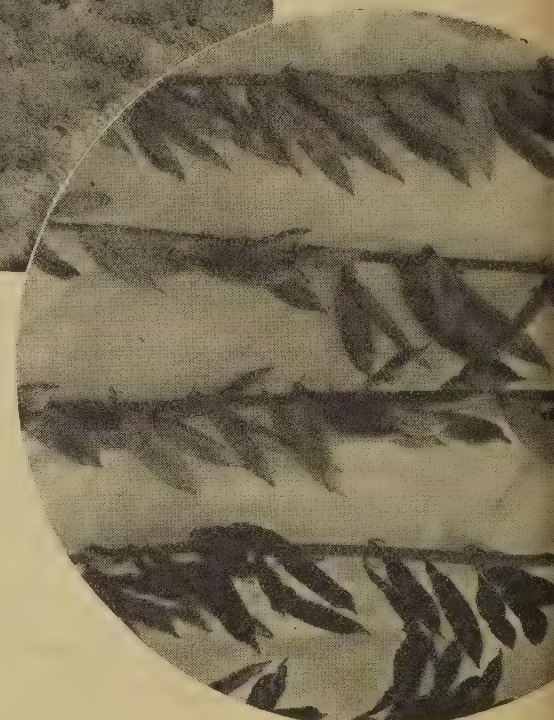
Protects High Plains

(*Continued from p. 140*)

Time is a factor of considerable importance from the standpoint of both vegetative response and operations. It has been observed that furrowing done in the spring about the time of heaviest rainfall gives a maximum response of grass with a minimum of weeds. Winter furrowing gives weed seeds a better chance to collect in the furrows, resulting in a greater growth of weeds. Grass will soon establish itself under this weed cover, however, in some instances deriving protection from extreme heat thereby. The work program of the farmer or rancher is another factor in determining the time of furrowing operations. Furrowing is beneficial, regardless of the time of year it is done. If the work program can be so arranged, spring furrowing nevertheless gives the grass its greatest opportunity to become quickly established.

Observational Plantings in

Sheep bush, a shrubby perennial from the South African desert plateau regions, which has proved its value for control of sheet erosion in the Southwest.



By F. J. Crider

Head, Section of Conservation Nurseries

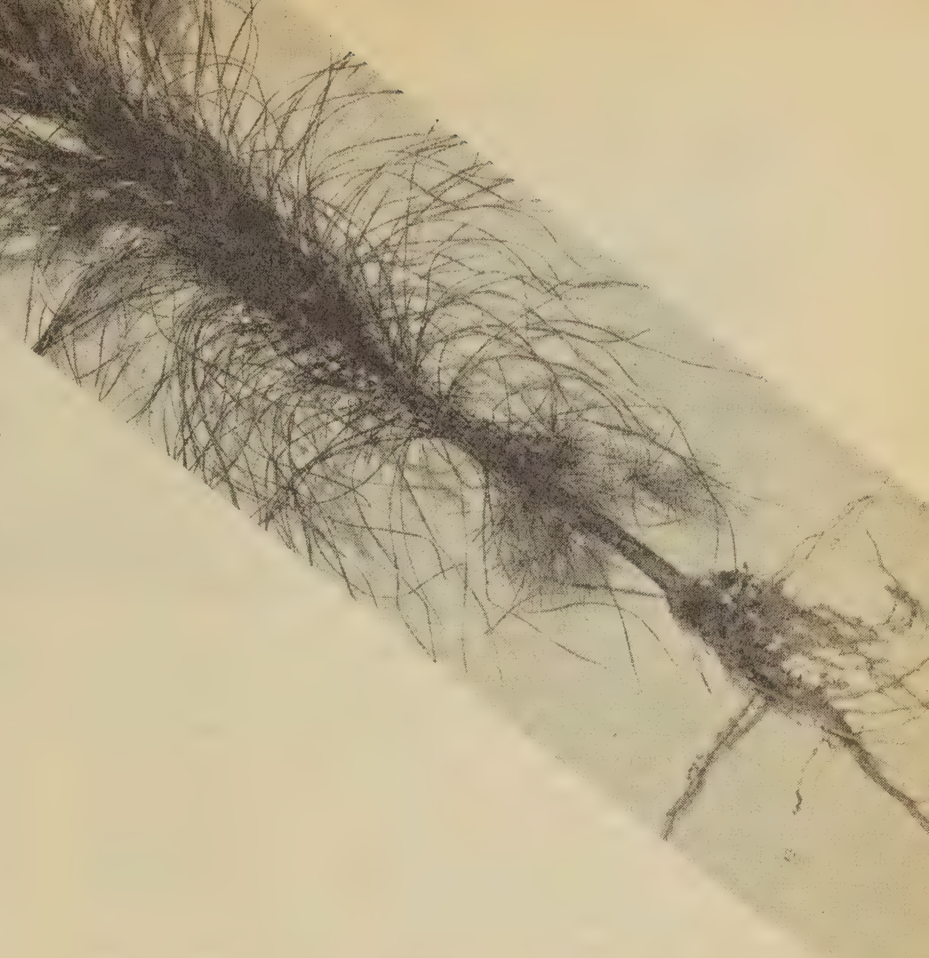
WHILE the major concern of the Nursery Section at this time is the production of nursery stock and the collection of seed in quantity for erosion control, a phase of its work of which the layman is not always aware is that of finding and bringing into use new plants which have outstanding value for the purpose in view—a constant flow of suitable plants to supply the needs of the project areas. This may be called the "observational" phase of the Soil Conservation Service nursery program. This work embodies the observation of a large number of species and variations of plants, and at the same time involves a most discriminating selection.

Plants must be chosen, in the first place, specifically for their known or potential conservational values. Plants which plainly possess no such values have no place in the observational plots. In line with the objective—a constant flow of suitable plants for erosion-control purposes—our seed and plant collectors are constantly on the lookout for native plants which in some outstanding particulars are worthy of being brought into the nurseries for further observation. Also, through special cooperative relations with the Division of Plant Exploration and Introduction of the Bureau of Plant Industry, and the efforts of our own Service, valuable introduced plants are being obtained for trial in the nurseries.

What is an Observational Planting?

A package of seed, from at home or abroad, acquired by design or chance; plantings in field or greenhouse for increase of seed; growth habits constantly observed, not only by the Nursery Section, but by all interested individuals and agencies of the Service, with a view to determining the plant's potential value and usefulness in connection with the various erosion control activities—this is the beginning of the "observational plant." Later, those species or strains which show promise are propagated in quantities sufficient for planting and trial under actual usable conditions. This affords opportunity for confirming nursery observations, more definitely determining relative plant values for particular purposes, and at the same time facilitates the development of successful methods

e nurseries



of vegetative propagation, transplanting, reseeding, and other operations essential to the establishment of plants in desired locations. Finally, those plants which pass the tests of practicability for the purposes in mind go into the quantity-production class and are grown and handled accordingly. This may be for nursery stock or seed production, depending upon whether the plants come within the category of trees and shrubs, or grasses and other forage crops.

Trees and Shrubs

It is not the purpose that observational plantings be maintained at all nurseries, but rather at not more than one or two in each region, depending upon the general conditions and needs. Growing methods are determined largely by the character of the plants. In the case of perennials, such as trees and shrubs, they are planted in comparatively small groups according to botanical relationships, usually in portions of the nursery not readily usable for quantity production purposes. Notable examples of such plantings are the Elsberry, Mo., and Zanesville, Ohio, nurseries, where

Below and in circles: **Astragalus rubyi,** *a legume recently discovered in the Ruby Valley, Mont., adapted to alkaline soils.*

the trees and shrubs are set out mainly on rather steep hillsides and along draws. In the nursery at Elsberry, containing a collection of over 500 varieties of trees and shrubs, many of the plantings are arranged (the general topography of the nursery permitting) so as to determine the relative slope-stabilizing value and exposure-adaptability of the plants, as well as other useful characteristics. Indicative of the nature of these plantings, the collection at Elsberry, for example, contains among other groupings 5 outstanding strains of black locust, 6 species of juniper, 67 varieties of willow, 28 varieties of filberts, and 30 species and strains of plums and cherries.

As the merits of particularly promising tree and shrub types become evident, and the need is created for more propagation materials (seed, cuttings, offsets, etc.) than the more or less limited facilities of the nurseries afford, it is hoped that the establishment of plantations of high-quality woody stock may be encouraged on farms or other suitable locations. It is possible that submarginal lands may, in some instances, be utilized advantageously for such purposes.

Grasses and Legumes

The more extensive collections of observational plantings consist of grasses and other forage crops in nurseries located in the Great Plains and Western States, the largest being at Pullman, Wash., and including more than 2,000 different species and variations. Although containing many native species, these collections are greatly augmented by introduced materials which were obtained largely through the Division of Plant Exploration and Introduction of the Bureau of Plant Industry.

A number of these accessions already show highly desirable characteristics. This is true both with respect to grasses and legumes. Particularly interesting from the standpoint of erosion control, combined with forage value, are several forms of *Astragalus* and *Trigonella* of spreading, compact, stoloniferous habit as well as a number of the grasses.

Cooperative Exchange

In connection with the observational plantings, the interregional exchange of small lots of seeds and plants is important in that it provides a means for wider utilization of materials having value for specific purposes. Also, through cooperative understanding, small lots of seeds of various kinds are collected for use by the Division of Plant Exploration and Introduction of the Bureau of Plant Industry in promoting seed exchanges with foreign countries. This offers opportunity for the nurseries to secure desirable exotic plants for trial, the importance of which is seen in the large number of introductions being used in the Service erosion-control program, and the number of promising foreign species under observation in the nurseries.

Plants from Abroad

There is usually a story behind the introduced plant. This one about sheep bush (*Pentzia incana*) is typical and at the moment opportune:

For centuries, sheep bush (called "karoo" in its native haunt) has covered the desert plateau regions of South Africa. Gradually it became known that as forage for sheep this shrubby perennial was a most dependable plant. An extremely drought-resistant plant in its native environment, sheep bush becomes dormant during the dry season so that it appears to be dead; but when the rains begin, it comes to life so quickly as to seem miraculous. As the sheep graze first on the more succulent vegetation, the karoo has adequate time to regain green foliage—a natural balance of rotation grazing most advantageous in desert regions. Today sheep bush is one of the principal plants in the South African desert plateau areas for sheep forage in times of severe drought.

Cover for the American Desert

The original introduction of sheep bush into the United States was made more than 35 years ago by Dr. David G. Fairchild who for many years served as head of the Division of Foreign Plant Introduction, Bureau of Plant Industry. The original packet of seed was obtained from native African stands, and plantings were made at the plant-introduction gardens at Chico, Calif. Little attention was given these plantings except by a few individuals interested in exotic plants, until a small amount of seed was supplied us for experimental plantings to be made under southwest desert conditions.

At the time, soil conservationists were deeply interested in a cover for the desert—useful plants that would hold the soil and could survive under conditions of severe drought. Along with some 30 or 40 other species of widely varying growth habits, plantings of sheep bush were made under desert conditions in Arizona. After a year or two, all species had disappeared except the sheep bush. This, from the Service point of view, constituted a thoroughly con-

The three grasses at the left proved sufficiently satisfactory in the observational nursery at Tucson, Ariz., to justify more extensive trials for erosion control under natural conditions. They are Eragrostis curvula, Eragrostis gp., *and* Chloris berroi. *The fourth,* Enneapogon cencroides, *was discarded because it was regarded as unsuited for the purposes in mind.*

vincing experimental result. The shrubby perennial from the South African desert-plateau regions had found a new home in the Arizona desert; it did not have to be aided by irrigation; it held the soil.

On Desert Range

In this observation under desert-range conditions, it was found that, in addition to possessing extreme drought-resistant qualities, sheep bush will reseed. This was in the way of a boon. The Service nurserymen are now propagating sheep bush for seed increase. Likewise, it is being planted in order to determine its further use for erosion control, especially in the Southwest. At present, the outstanding feature about this shrubby perennial is its value for general revegetation and control of sheet erosion—this because of its procumbent habit—combined with its high forage value, which is almost equal to that of alfalfa.

Thus karoo from the South African desert plateau came to the desert range of the Southwest.

And sheep bush is but one of many foreign plants now under observation at the various nurseries of the Service which already have demonstrated valuable characteristics for erosion control.

Plants from the Orient

Another interesting plant now being grown and propagated in the Soil Conservation nurseries is mahuang (*Ephedra sinica*), a low mat-forming perennial which possesses splendid sandbinding properties and extreme drought resistance combined with possible commercial value. Since this plant, introduced from China, produces the commercial ephedrin drug, it is hoped that it can be used more or less extensively on Indian reservations to hold the sand, and to provide monetary income for Indians having little source of livelihood. With its extraordinarily compact and deep root system, mahuang should be of inestimable value in the prevention of sand blowing.

A special strain of arborvitae, *Thuja orientalis*, is being propagated as rapidly as possible at the Elsberry, Mo., nursery. This hardy, upright, and fast-growing strain of arborvitae is especially suitable for windbreaks, being able to maintain itself under adverse conditions with no care whatsoever.

A trailing raspberry from Japan, *Rubus parvifolius*, with edible berries, is now under observation at the nurseries in several regions. This trailer has splendid soil-holding properties and is excellent for bird feed; but its most commendable property is that of its resistance to the usual raspberry and blackberry pests. It should therefore be of value in those localities where the climate is suitable for its growth and where a plant combining qualities indicated above is desired.

South African Grass

In the Southwest *Eragrostis curvula*, a perennial bunch grass which is a native of South Africa, is being grown in the nurseries for seed increase and project plantings. This grass is especially valuable because of its drought resistance, deep-root system, and its ease of propagation both vegetatively and by seed. Its heavy seed crops are easily harvested—an important feature—and it has been learned from observations that it will reseed under natural conditions. In the same

A view of the observational nursery at Pullman, Wash.

region, nurseries are trying out *Eragrostis sp.*, a mat-forming perennial grass (the best of some 30 grasses sent us by Miss M. Wilman of Kimberly, South Africa) which has special soil-binding advantages in that its offsets on prostrate culms take root readily. This grass is now being grown for seed increase and project plantings.

Ruby Valley Legume

The discovery of a heretofore overlooked native species is always highly satisfying to the plant collector. Of interest in this connection is a legume which was discovered recently in the Ruby Valley of south central Montana. This is *Astragalus rubyi* which in its native habitat is found growing in association with alkali grass and salt grass. *Astragalus rubyi* promises to become in the intermountain regions a forage legume of primary importance, and observational plantings made at different nursery centers suggest successful adaptation of this native species to a wide range of soil and climatic conditions. It is particularly adapated to soils of high alkali content.

Immune to Cedar Rust

Another native plant of special interest is the Ozark white cedar, a small spreading tree found growing in northwestern Arkansas and southwestern Missouri. This tree is particularly valuable because of its immunity to cedar rust, which restricts the use of common red cedar. In addition, Ozark white cedar has the further advantage of being able to grow under extremely adverse conditions. This small tree can be utilized for fence posts and its seed for bird feed. It is being grown and propagated at the Elsberry, Mo., nursery in the expectation that it will prove valuable for plantings in certain locations.

Native Tree and Layering Shrub

A striking example of variation in native woody plants, for which our plant collectors are watchful, is a strain of the wild olive (*Forestieria neomexicana*) found in Arizona, which differs from the more common form by its distinctly layering habit. This characteristic makes the plant especially valuable for the stabilization of gully slopes. Its value is further enhanced by ease of propagation and transplanting and the production of berries as food for birds. Stock plants are being grown in the nurseries for observation and as a source of propagation material.

Seed Production

Within the scope of "observational plantings" also comes the matter of determining the possibility of seed production under cultivation of certain grasses native to the United States, and this is becoming an increasingly important nursery function. Some of the more valuable range-erosion control grasses, as well as browse plants, have become almost completely eradicated by overgrazing and other improper land usage practices, so much so that it is impossible to collect seed of them in quantities sufficient for reseeding, the only recourse being to find out how to produce successfully the seed under cultivation. Again, in some sections there are years when, on account of prolonged

(*Continued on p. 151*)

COSTS COME DOWN ON 1,937 MILES OF TERRACES

By T. S. Buie [1]

Sharp downward trends in construction costs of terraces, treatment of terrace-outlet channels, and gully control during the 4 months' period from July to October, inclusive, are reflected in cost reports for the Southeastern Region.

In spite of an increase of 12.5 percent due to a change in wage rates for tractor operators in the region since July 1, terrace construction costs showed a decrease of approximately 16 percent for October as compared with July, very likely due to increased efficiency.

A decrease of 32.7 percent in the costs of treatment of terrace-outlet channels during the same period is attributed by our engineers to the more extensive use of meadow strips and other vegetated waterways for outlet channels, instead of the masonry and concrete structures formerly used.

Gully-control costs for the region show a decrease of approximately 34 percent. This is probably due largely to the comparatively recent practice of diverting the headwater from gullies, which virtually eliminates the necessity for permanent structures and greatly reduces the number of gully-control structures required.

In this connection it might be pointed out that where gullies are found in cultivated areas diversion of the headwater can usually be accomplished by terraces which drain the water away from the gully. Under other conditions this is accomplished by diversion ditches which can be constructed with machinery at much less than the cost of control structures in the gully itself.

By diverting the headwater, control of gullies can be effected much more readily with vegetation, since growth can be established with a minimum of mechanical structures once the volume of water flowing through the gully has been reduced to the amount of water falling directly into the gully and running down the sides.

Prior to July 1 the large amount of labor on relief rolls made it necessary to do more gully work than has been necessary since that time. Originally a large item in the cost of field operations, gully-control work is no longer a major activity.

The 16-percent decrease in terrace-construction costs was based on a total of 1,937 miles of terraces constructed in the Southeastern Region from July 1 to October 31. During the same period terrace-outlet channels constructed had a drainage area aggregating 17,241 acres, and gully-control work benefited 8,184 acres.

[1] Regional conservator, Spartanburg, S. C.

Observational Plantings

(*Continued from p. 150*)

droughts, the more abundant of the native grasses used in the erosion-control program are a failure. During such periods, particularly where irrigation facilities are available, cultivated plantings can be relied upon as a source of seed.

Favoring the practice of producing seed of native grasses under cultivation, as already demonstrated in some of the nurseries, good yields and purer seed may be expected from grasses so handled. Also, the information secured through such procedure, along with its demonstrational value, has the effect of encouraging farmers and stockmen to undertake the production of seed of these grasses as a cash crop. In a few instances in the Great Plains area this is already being done.

COMING.—A second article by Ben Osborn and H. L. Whitaker on *Mapping Natural Vegetation as a Background for Erosion Control and Wildlife Management;* a review of machinery developments, by Gerald E. Ryerson; discussions of cooperative relations, and cost-cutting.

Portion of an aerial photograph of a contoured field in Oklahoma.

PLANTING MATERIALS USED IN SOIL CONSERVATION

By L. D. Eagles[1]

A balanced soil conservation program involves the use of numerous seeds for strip crops, pastures, meadows, terrace outlets, cover crops, and green manuring. Before the practices could be introduced on many farms under agreement, it was necessary to apply commercial fertilizer and limestone. In some areas the slopes were so sharp and so badly eroded that it was inadvisable to plant cultivated crops, and for that reason kudzu crowns and trees came to play an important role.

During 5 months, July to November 1936, inclusive, the Soil Conservation Service purchased 2,807,173 pounds of seed for agronomic use. Of this quantity 2,142,061 pounds consisted of annual grasses, cereals, etc., used for cover crops, strip crops, pastures, meadows, and terrace outlets. Legume seed made up approximately one million pounds. The legumes are used for pastures, meadows, strip crops, terrace outlets, cover crops, green manure crops and forage crops. Perennial grasses which are used primarily for pastures, meadows, terrace outlets, and forage made up approximately three-quarters of a million pounds.

The following table shows the kinds, amounts, and principal uses of seed and other materials purchased through the Nursery Section during the 5 months covered:

[1] Associate agronomist, Nursery Section, Soil Conservation Service, Washington, D. C.

Item	Principal use	Amount
		Pounds
Oats (*Avena sativa*) and (*A. byzantina*)	Cover and strip crops, pasture	1,657,316
Rye (*Secale cereale*)	do	449,980
Austrian winter peas (*Pisum sativum*)	Cover and strip crops, green manure	215,720
Hairy vetch (*Vicia villosa*)	do	192,170
Western wheatgrass (*Agropyron smithii*)	Revegetating for permanent grazing	170,080
Alfalfa (*Medicago sativa*)	Strip crops, pasture and meadow	135,750
Biennial white sweet clover (*Melilotus alba*)	Pasture, strip, and cover crops	107,274
Smooth brome grass (*Bromus inermis*)	Pasture and hay mixtures, terrace outlets	103,305
Orchard grass (*Dactylis glomerata*)	Pasture, terrace outlets	73,450
Crested wheatgrass (*Agropyron cristatum*)	Revegetating dry lands for permanent grazing, terrace outlets	69,392
Slender wheatgrass (*Agropyron pauciflorum*)	Revegetating for permanent grazing	69,050
Italian or domestic ryegrass (*Lolium sp.*)	Pastures	59,680
Southern spotted bur clover (*Medicago arabica*)	Pasture-cover and green manure crops	53,700
Cowpeas (*Vigna sinensis*)	Cover and strip crops, green manure and forage	45,000
Redtop grass (*Agrostis alba*)	Pasture and meadow	41,675
Crimson clover (*Trifolium incarnatum*)	Strip crops, pasture, cover and green manure	34,350
Kentucky bluegrass (*Poa pratensis*)	Pasture, terrace outlets	32,729
Dallis grass (*Paspalum dilatatum*)	Pasture	31,505
Wheat (*Triticum vulgare*)	Cover and strip crops	31,400
White Dutch clover (*Trifolium repens*)	Pasture	29,765
Timothy (*Phleum pratense*)	Pasture and meadow	25,295
Hop or suckling clover (*Trifolium dubium*)	Pasture	21,835
Alsike clover (*Trifolium hybridum*)	Pasture and meadow	20,794
Red clover (*Trifolium pratense*)	Meadow, strip crops, pasture	18,055
California bur clover (*Medicago hispida*)	Pasture, cover and green manure crops	16,700
Biennial yellow sweet clover (*Melilotus officinalis*)	Pasture, strip and cover crops	16,200
Hubam clover (*Melilotus alba annua*)	do	12,300
Bulbous blue-grass (*Poa bulbosa*)	Winter pasture and cover crops	9,775
Black medic (*Medicago lupulina*)	Pasture	7,960
Sour or annual yellow sweet clover (*Melilotus indica*)	Pasture, strip and cover crops	6,700
Canada bluegrass (*Poa compressa*)	Pasture	6,560
Chinese lespedeza (*Lespedeza sericea*)	Pasture, strip and meadow	6,200
Perennial ryegrass (*Lolium perenne*)	Pasture, meadow, terrace outlets	5,050
Carpet grass (*Axonopus compressus*)	Pasture, terrace outlets	3,950
Meadow fescue (*Festuca elatior*)	Meadow, pasture	3,798
Zawadke grass (*Puccinellia nuttalliana*)	Revegetating alkali soils	3,000
Reed Canary grass (*Phalaris arundinacea*)	Pasture, meadow	2,765
Indian wheatgrass (*Plantago sp.*)		2,750
Bermuda grass (*Cynodon dactylon*)	Pasture, terrace outlet	2,600
Rescue grass (*Bromus catharticus*)	Winter cover and pasture	2,000
California brome grass (*Bromus carinatus*) or (*B. marginatus*)	Pasture	2,000
Alfilaria (*Erodium cicutarium*)	Pasture and meadow	1,750
Sudan grass (*Sorghum vulgare sudanense*)	Strip crops, pasture and meadow	1,515
Tall oatgrass (*Arrhenatherum elatius*)	Meadow and pasture	1,500
Persian or Shaftal clover (*Trifolium resupinatum*)	Pasture	750
Tall or reed fescue (*Festuca elatior arundinacea*)	Pasture and meadow	550
Korean lespedeza (*Lespedeza stipulacea*)	Strips crops, pasture and forage	400
Sheep fescue (*Festuca ovina*)	Pasture and meadow	300
Fenugreek (*Trigonella* (*foenum-graecum*)	Cover and green manure crops	300
Rhodes grass (*Chloris gayana*)	Forage	300
Sainfoin (*Onobrychis viciaefolia*)	Green manure, forage and pasture	115
Rape (*Brassica napus*)	Pasture	100
Red fescue (*Festuca rubra*)	do	15
Kudzu (*Pueraria thumbergiana*)	Cover crops, pasture, forage and gully control	[1] 2,264,000
Tree seeds	Nursery tree production	34,595
Trees	Woodland management reforestation	4,327,300
Sphagnum moss	Packing nursery stock	61,400
Commercial fertilizer	Terrace outlet and pasture improvement	[2] 4,040
Agricultural limestone	Soil improvement for legumes	[2] 1,012

[1] Crowns.

[2] Tons.

WILDLIFE-SAVING FARM PONDS OF MISSOURI

By Cecil N. Davis[1]

Gully before dam was built.

During the summer of 1936, with stream beds dry and wells inadequate, the wildlife of Missouri congregated at thousands of ponds built by far-seeing farmers in recent years. Many of these had been provided as a part of the program of the Soil Conservation Service.

Gullies are favored as locations for ponds. The dams may back up water over a small overfall at the head of the gully, or a large structure farther down may help to fill branch gullies as well. This feature makes the building of ponds a successful and economical erosion-control practice.

As most farmers in this section are poorly supplied with water, the ponds aid the agronomist in his crop rotation program, especially that of rotation grazing. Many fields of prospective cooperators have neither wells nor facilities for piping water from a distance, and springs in north Missouri are rare. Thus, the damming of a gully in a field designated as a temporary or permanent pasture often solves a knotty problem of

Pond just filled. No plantings made. Same gully as shown at left.

[1] Acting wildlife conservationist, Soil Conservation Service.

Vegetation holding 2-foot fill in inlet of pond, and providing food and cover for wildlife. Eight species 1 year old.

Submerged vegetation after 1 year's growth, providing protection and cupboard for small fish.

water supply, especially where beef-cattle and sheep are grazed or where young cattle are pastured for the season.

Forester's Viewpoint

As for the forester, his interest in the pond-development program on Missouri farms lies, chiefly, in the fact that it provides a larger and better-distributed water supply in the event of fires. At the same time, he is not indifferent to the fact that the raising of the water table may mean the survival of the black locusts, willows, or other trees which he may have planted in the vicinity.

From the standpoint of wildlife conservation a water supply is much more important than is generally realized. Food and shelter are the points usually emphasized as the controlling factors for upland game within their natural range, but only those who have observed them during the last two droughts know how birds, game, and fur-bearers concentrate near water supplies.

Counts of twoscore birds at one time in trees near an open spring are common. In August 1936 many muskrats were observed moving away from dry creeks to more moist locations.

Based on observations in the past three years, the following points are considered of outstanding importance for the most complete soil, water, and wildlife conservation program with ponds:

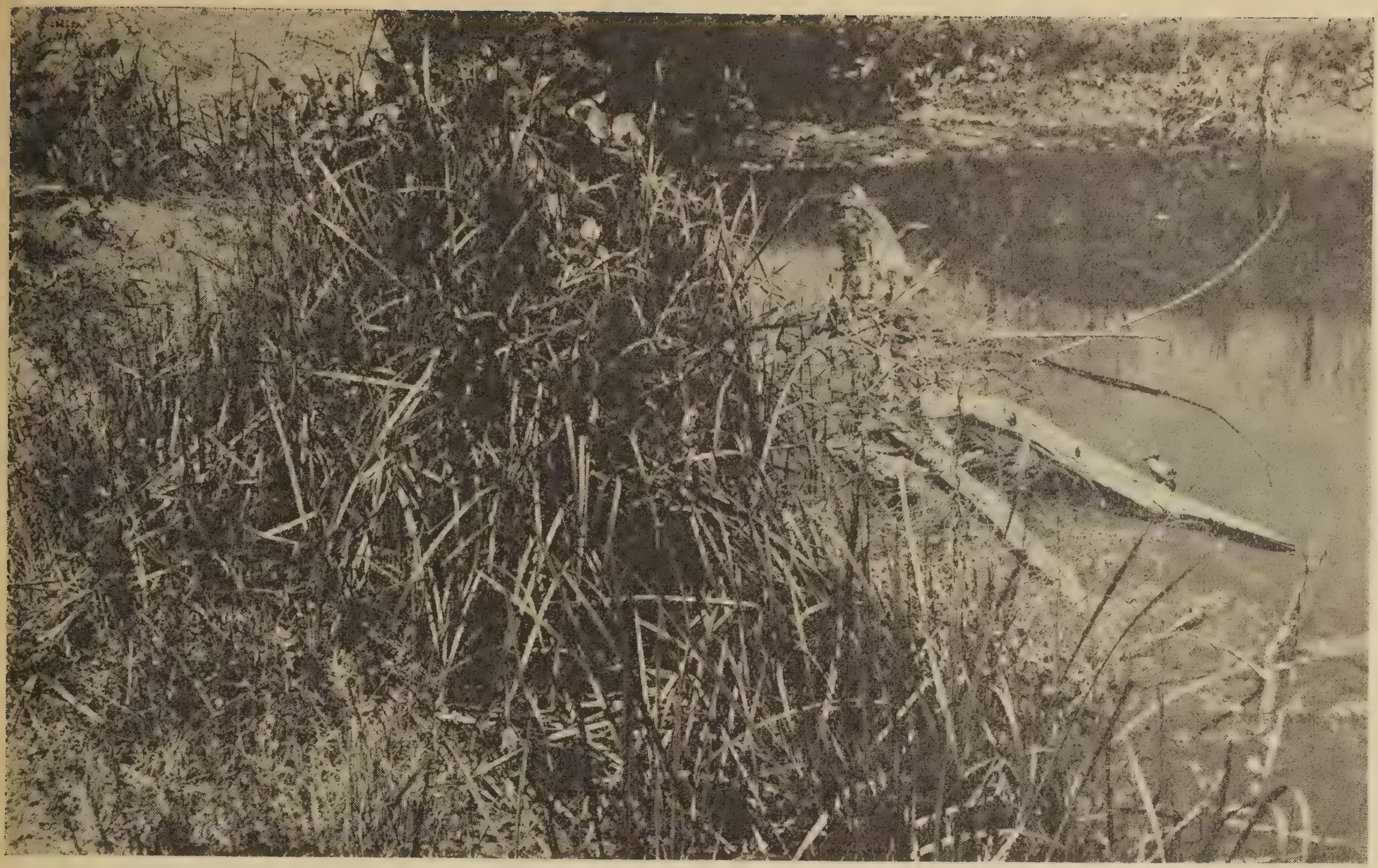
First, the pond should be at least one-half acre in size and at least 7 feet deep if it is to be used for watering livestock.

Second, any drainage from the farmstead should be diverted from the pond.

Third, the pond, dam, outlet, all raw land scalped to provide fill for the dam, and preferably an additional area equal to all the preceding, should be fenced stock-tight and protected against fire. Livestock should be watered by means of tanks fed by a gravity pipe line under the dam or by a windmill pumping from a pool by the side of the pond.

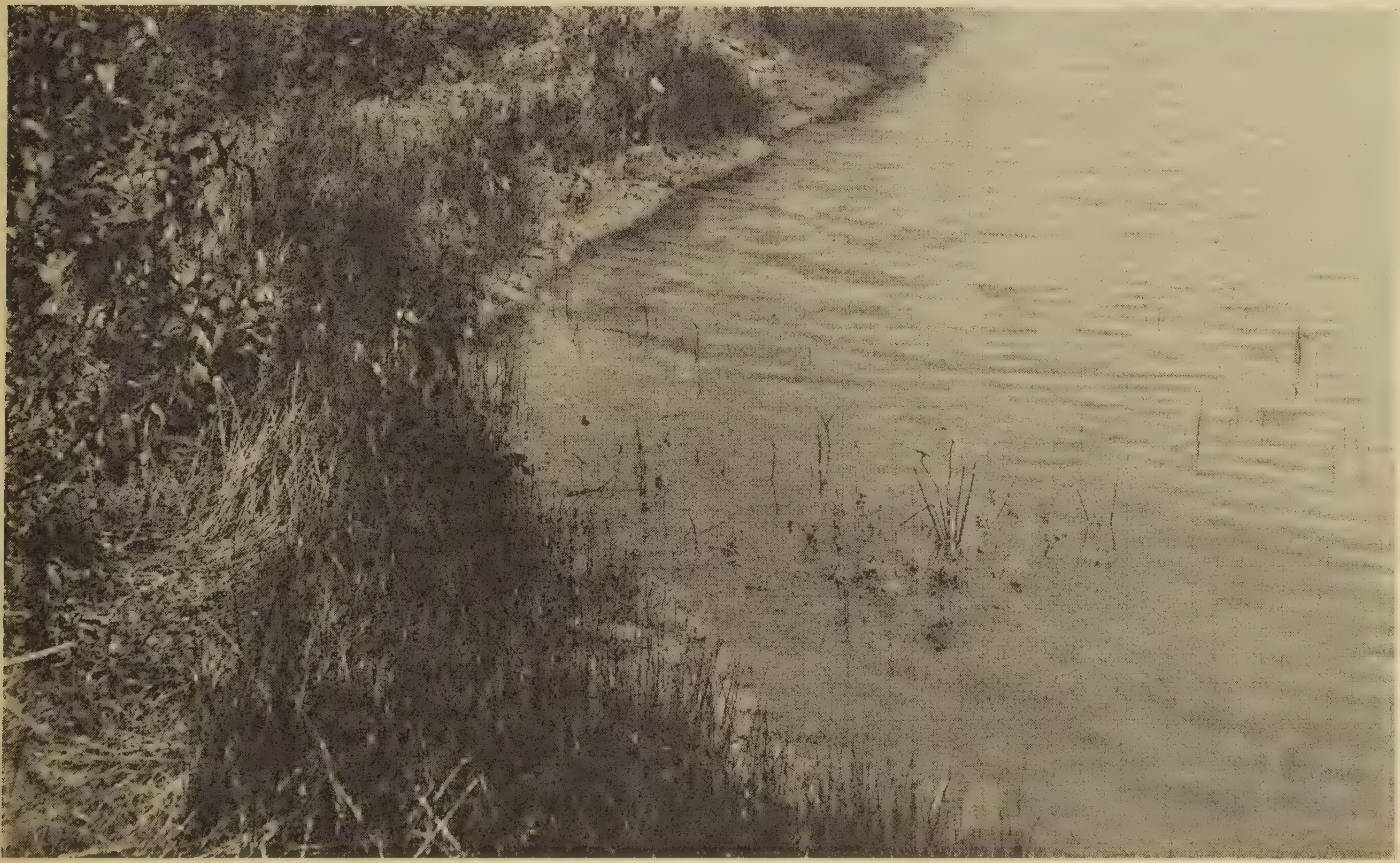
Fourth, proper environment for fish should be provided by introducing water plants of such types as will insure a renewal of the oxygen supply, food and protection for small fish, and support for fish-food animals. Certain of the plants will provide also dams for silt at the inlets of the pond, protection from wave action against the pond dam, and food as well as protection to birds, fur-bearers, and other wildlife fre-

(Continued on p. 159)



Burr-reeds on banks of pond one year from planting date, with new plantings in background. Three redwing blackbirds made nests in the reeds.

Protection against wave action proved by reeds and arrowhead one year after planting. Note the low water line.



THE LIFE HISTORY OF RAINSTORMS

Progress Report From the Oklahoma Climatic Research Center

By Katharine C. Hafstad [1]

A typical weather station in Blaine County, Okla., showing the installation of instruments.

The Oklahoma Climatic Research Center was established in October 1935 for the detailed study of local climatic variations which condition local differences in soil erosion. To this end nearly 200 weather stations spaced on an average of 3½ miles apart were established in Blaine, Kingfisher, and Logan Counties by the Division of Climatic and Physiographic Research in cooperation with the United States Weather Bureau and with the assistance of Works Progress Administration funds. Farmers selected from the relief rolls were trained as meteorological observers and a set of weather instruments was installed on each of their farms. Included are a rain gage, maximum and minimum thermometers, fan psychrometer, wind vane, and anemometer. Observations are made hourly from 7 a. m. to 7 p. m., and during storms the rainfall is recorded at 15-minute intervals. That which falls after 7 p. m. is collected and measured the following morning at 7 a. m. In addition, 100 supplementary self-recording rain gages have been installed on alternate farms on an average of 4½ miles apart. These supply continuous records of snow and rainfall for the entire duration of the storms.

120 Maps a Day

The observations are mailed to the Kingfisher headquarters where the data are transcribed onto maps under the direction of the project leader, Leonard B. Corwin. The actual work is performed by an office staff consisting chiefly of Works Progress Administration workers. For each day an average of 120 maps are prepared. These include daily maximum- and minimum-temperature maps and hourly maps of temperature, wind velocity and direction, relative humidity, and cloudiness. Rainfall maps are prepared for each 15-minute interval and for the accumulated rainfall by 15-minute intervals, by days, by months, and for the year beginning January 1, 1936. To insure accuracy the instruments are all tested weekly and if the observations are inaccurate, the finished maps will show inconsistencies which can easily be traced to their source. The few observers who failed to keep accurate records were readily identified and immediately discharged.

Reviewed in Washington

When the maps are complete they are sent to Washington for analysis and interpretation. In the January 1937 issue of the *Geographical Review*, Dr. C. W. Thornthwaite, head of the Division of Climatic and Physiographic Research, has presented the results of a preliminary analysis of these maps. The spotty character of the rainfall in the Great Plains has long been recognized but heretofore it has not been possible to obtain observations from a sufficiently large number of stations or at intervals short enough to permit a study of the rainfall distribution and its causes.

Recent studies of the Division of Climatic and Physiographic Research show that in the Great Plains the annual distribution of rainfall is neither cyclic nor synchronous and no pattern of rainfall distribution has as yet been determined. For example, the year 1919 was the driest for the entire period from 1905 through 1934 at Emporia, Kans., while it was the wettest at Phillipsburg.

Behavior Varies with Types

In the *Geographical Review*, Dr. Thornthwaite has presented a detailed analysis of five type storms which occurred over the project area in the spring of 1936. These show clearly that storms of different types have definite patterns of behavior, that the types "are sufficiently characteristic in size, shape, and distribution of intensity to be classified according to their morphology", and that through the study of a sufficient number it may be possible to develop a taxonomy of

[1] Assistant soil conservationist (climatic research), Soil Conservation Service, Washington, D. C.

storms. If a storm of recognized type is reported by one of the established Weather Bureau cooperative stations, it may be possible from their data to forecast the behavior of the storm as well as the extent of the area which will be affected by it. Storm centers may or may not migrate. In the former case stations similarly located with reference to the center of the storm will report similar rainfall curves but the points of maximum intensity will occur at different times depending upon the rate at which the storm travels.

Polar Front Type

The rains of April 26 and 27 are of the Polar front type in which the front oscillates back and forth within narrow limits. On both days the precipitation occurred within the area of frontal oscillation.

On April 26 the station which first reported rainfall also reported the greatest total amount of precipitation (2.49 inches) for the entire storm and the maximum intensity (0.64 inch in 15 minutes) was experienced successively by three adjacent stations. Although the storm expanded and contracted areally, the center of greatest intensity never shifted more than 10 miles from the point where rainfall was first reported. With the exception of a few isolated stations, the precipitation was limited to the western third of the project area.

During the storm of April 27 scattered light showers occurred over the entire area in the morning. By afternoon, centers of high rainfall intensity (over 0.60 inch in 15 minutes) were reported by six stations in Logan County to the east but no rain fell in the western half of the area.

Storms of this type show why it is futile to correlate either crop production or erosion with average rainfall. The total rainfall over an area may be the same but one section may receive it at a critical period for plant growth. In another locality it may come when the soil is bare, and merely accelerate sheet or gully erosion.

Migratory Type

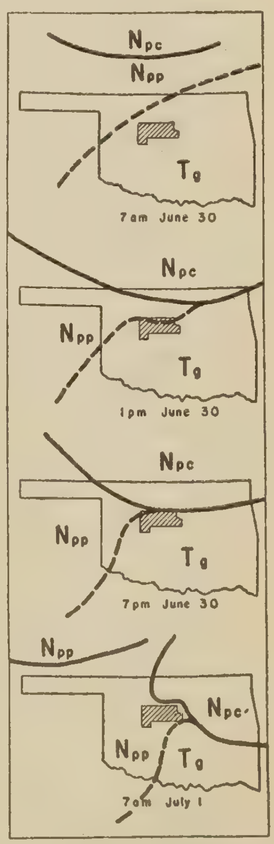
The storm of May 1 (illustrated by colored maps in the *Geographical Review*) is of the migratory type associated with the passage of a Polar front from northwest to southeast across the project area. By 4 p. m. the front had made its appearance in the northwest corner of the area, winds shifted from south to north, and the temperature dropped about 10° F. The same phenomena, with a fall in temperature of about 30° F., were observed progressively throughout the area and shortly after 7 p. m. the Polar front passed beyond the southeast corner. At 5 p. m. several irregular waves developed along the wind-shift line in Blaine County to the west, near the center of the area similar waves appeared at 6 p. m., and an hour later identical behavior was observed in Logan County to the east. This would indicate that the same waves had traveled eastward with the storm. As the amplitude of the waves increased centers of intense rainfall developed.

Centers of maximum rainfall intensities occurred in 13 different areas progressively from northwest to southeast, along the Cimarron Valley, the maximum intensity for any 15-minute period being 1.54 inches. During the storm more than 3,500,000,000 cubic feet of water fell on that portion of the Cimarron watershed within the project area. Information of this type suggests that rainfall-morphology studies offer a new approach to the flood problem.

Storm of June 30

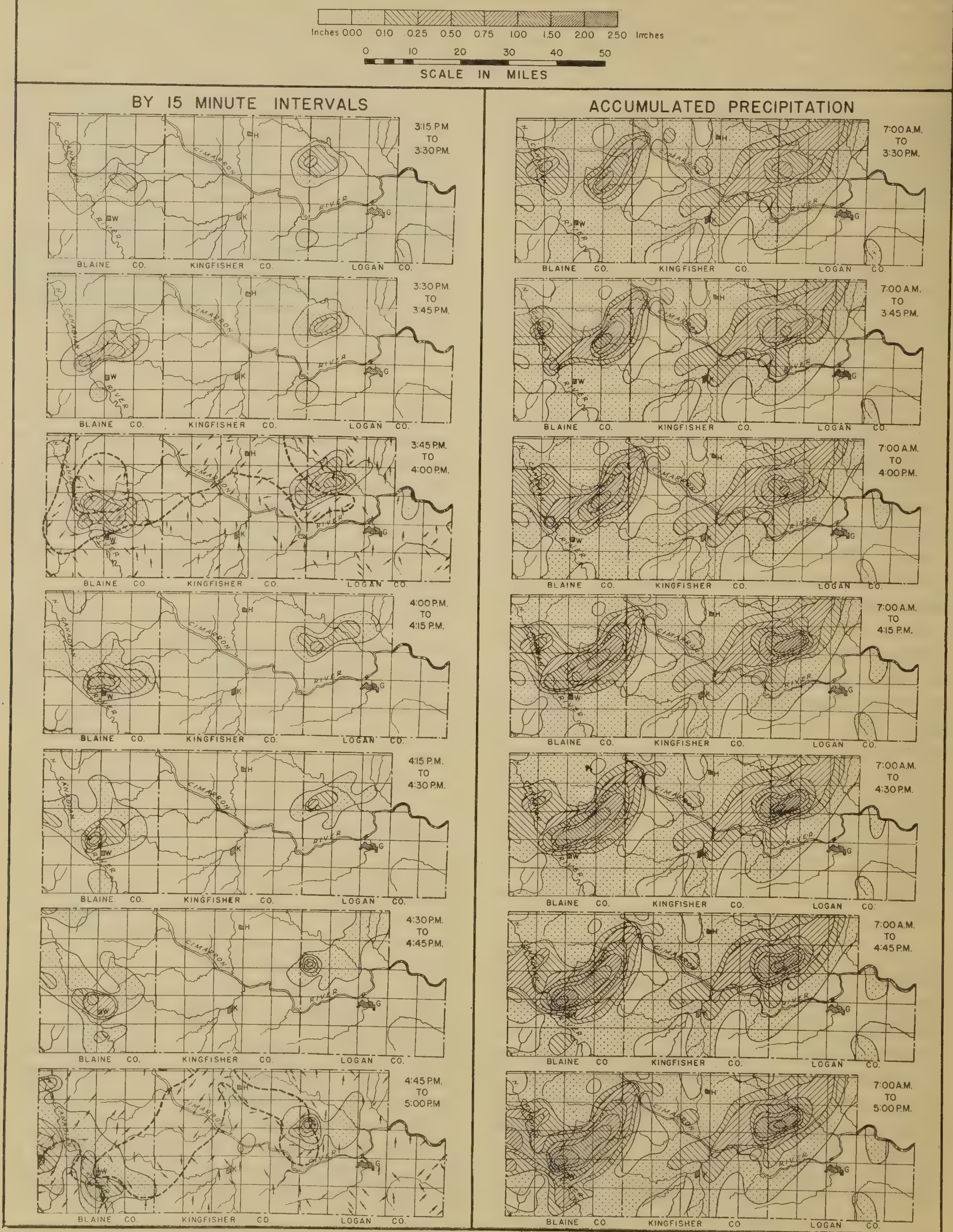
Maps of the storm of June 30 are reproduced in connection with this article. From these it can be seen that the storm was of the stationary type and that it was of particular interest because it possessed two centers of rainfall intensity. During the early morning, Tropical Gulf (Tg) air overrode first the Modified Polar Pacific (Npp) air and later the Modified Polar Continental (Npc). The approximate positions of the discontinuity surfaces between the air masses are shown in the small panel of maps. Scattered light showers were reported by 30 stations during the morning. Between 3 and 3:15 p. m. the storm centers shown in the series of maps developed, and for the period 0.41 inch was reported by each. Thereafter rain continued to fall in these separated centers, amounting to a total of 2.27 inches in the Blaine and 3.81 inches in the Logan County center. However, stations less than 5 miles from each of the centers reported only traces (less than 0.01 inch) of rainfall.

Of the five storms described by Dr. Thornthwaite, only that of May 8, associated with a warm front, brought widespread and fairly evenly distributed rainfall to the entire project area. The storms of April



Successive positions of the Polar front during the storm of June 30, 1936.

RAINSTORM OF JUNE 30, 1936



26 and 27 were limited each to less than half of the areas, that of May 1 followed, in general, the Cimarron watershed, and that of June 30 had two widely spaced centers of maximum intensity, with rainless areas intervening. However, in each case the spottiness of the rainfall was associated with definite types of storms which are characteristic of the Great Plains. "In 2 or 3 years enough could be learned about the characteristics of storms in western Oklahoma to make it possible to approach the problems relating to soil and moisture conservation, land use, and flood control on an intelligent basis."

Varying Velocities Within Mass

Another phenomenon of great significance from the standpoint of soil conservation is shown by the wind charts reproduced in the *Geographical Review.* Parallel streams of air of different velocity develop in the main air mass. These streams or channels are parallel to the wind direction and are evidently not related to topographic features since they develop with winds from any direction. The wind may blow at the rate of 5 miles per hour at the edges of the channel and attain a velocity of 18 miles near the center. Further research is necessary to determine whether or not the channels tend to recur in definite positions or patterns, and it is suggested that such research may solve the problem as to why "some fields may suffer greatly from wind erosion and adjoining fields remain practically undamaged, even though soils and land use appear to be identical."

In conclusion Dr. Thornthwaite points out several important implications of rainstorm morphology analysis which indicate the need for the establishment of projects similar to the Oklahoma Climatic Research Center in entirely different climatic regions. Such analysis permits the determination of rainfall frequencies with far greater precision than formerly. Consequently when the expectancy of different types of storms for an area is established, the frequency of various precipitation intensities "may be determined by relating the area regularly experiencing this intensity to the total area of the storm". By determining the areal extent, intensity, and distribution, the total water content, and the usual migration habits of storms, the probable occurrence of rainfall over a given watershed during a storm of recognized type may be estimated. From information on the total amount of water deposited on a watershed, and its rate of fall, together with data on temperature, evaporation, and soil characteristics, the hydrologist will be able to compute with much greater accuracy the amount of run-off, infiltration, and the percentage of the total precipitation which may be added to the ground water.

The work of the climatic research center also illustrates the futility of trying to correlate soil erosion with monthly, weekly, or even daily precipitation. "The course of events must be traced step by step during individual storms." After type storms have been identified and their expectancy in a given area established, it will be possible to interpret data from existing weather stations more effectively from the standpoint of erosion and its control. Similarly, information concerning the magnitude and migration of type storms supplies data more suitable for the correlation of rainfall and crops than the average values which have heretofore been used.

Farm Ponds of Missouri

(*Continued from p. 154*)

quenting the water's edge. Seventeen species of leafy plants and shrubs have been planted in the Service-built ponds in Missouri, the most important of which are included in the following genera: *Saggitaria, Alisma, Polygonum, Echinochloa, Junens, Cyperus, Potomogeton, Ceratophyllum,* and *Spirodelia.*

Fifth, if possible the watershed should be planted to a permanent cover of sod or woodland. All raw areas on the dam and the edges of the borrow pit should be revegetated as soon as possible. Plantings of shrubs, such as buttonbush, red osier, dogwood, and wild plum, for protection and food for wild fowl and upland game, for erosion control, and for cooling the water should be made. Only a few trees need be used on the south and southwest sides, but not on the dam itself. Trees such as hackberry, hickory, black cherry, red cedar, red mulberry, and the native oaks are good; but cottonwood, elm, and willow may seed so profusely that they will overrun the area and, therefore, should not be encouraged. The shrub plantings should be in clumps, and should all be localized at one side or one end of the pond area, leaving the remainder an open grass plot for the freer utilization of the pond by waterfowl and for nesting sites for such species as quail and meadow lark.

Sixth, for the best use of the pond it is advisable to have supplementary wildlife cover and food in fields nearby. Often the gully below the pond can be fenced out and planted in erosion-control vegetation. Such a place makes an ideal lane for wildlife and may lead to waste areas, ungrazed meadows, overgrown fence rows, or a prepared wildlife area planted to shrubs and vines.

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

DEFICIENCIES IN BASIC HYDROLOGIC DATA. Special Advisory Committee, National Resources Committee. Washington, September 1936.

As set forth in this report of the special advisory committee on standards and specifications for hydrologic data, there is urgent need for additional knowledge concerning the behavior of water as it falls as rain or snow, is absorbed by the soil, runs off in streams or torrents, and is evaporated, for the well-ordered development of sound water conservation in the United States.

Herein is a discussion in some detail of factors involved in the gathering of accurate long-term hydrologic records as essential to efficient flood control, economical irrigation, effective water-reserve systems and land-drainage facilities. The cost factor in particular is stressed.

The past 6 years have seen severe drought conditions over large areas of the country. In these areas, losses to agriculture, stock and public water supplies have mounted into the hundreds of millions of dollars and have seriously impaired public welfare. Although no human power could have prevented the drought period itself, none the less by water conservation methods based upon precipitation, ground water, and evaporation records over a ong period of time, many of the serious losses could have been lavoided or at least reduced.

Other sections of the country suffered more or less disastrous floods. Expensive dams broke and waters flooded farms, cities, and villages; lives were lost and the costs soared. According to findings resultant from intensive studies made by the special advisory committee, these more or less major disasters might have been avoided had there been existent, as background for water-conservation methods, long-range records of the following natural conditions: Rainfall at high elevations; rainfall intensity; snowfall on mountain slopes in important drainage areas; maximum, mean, and minimum stream-flow; ground-water levels; evaporation, including that from snow and ice; impurities in water and their effects on health and on plant and animal life; soil conditions and vegetative cover; transpiration.

In the light of the above-mentioned requirements, the committee urgently recommends many additions and specific changes for the installations and expenditures essential to a permanent program for the gathering of long-term hydrologic data.

In regard to precipitation it is suggested that data of this kind should be made more effective "by the inspection and rehabilitation of existing precipitation stations; by the publication of hitherto unpublished precipitation records; by the establishment of 1,200 new cooperative rainfall stations in localities where rainfall is not now measured; by the establishment of 6 new first-order meteorological stations in high altitudes; and, especially, by the establishment, of 400 recording rain gages to collect data on intensity of rainfall, properly distributed as to area so as to average one to every 5,000 square miles." Summarizing costs for improving precipitation data, the committee estimates that the first year total would amount to $396,000; while in succeeding years, with the program once installed, the total cost would drop to $223,000.

The establishment of at least 500 snow-survey courses in mountain areas is recommended for the improvement of stream-flow forecasts above important irrigation, navigation, flood control, and power projects and privately irrigated lands. In connection with this it is stated that Federal interests are largely involved. In addition to the network of snow-survey courses, additional research at a few selected experimental courses should be initiated promptly to provide improvements in techniques employed in both old and new courses. As to cost for improving snow surveys, the committee recommends that distribution arrangement be such that Federal agencies supply some $169,000, while non-Federal agencies produce for installation purposes an amount not to exceed $13,000.

For the extension and improvement of stream-flow data the committee suggests the establishment of 500 base stream-gaging stations with 600 cooperative secondary stations, and in addition, the rehabilitation of 1,000 old stations. That a network of Federal stations is absolutely essential to a consistent and productive program of stream-flow measurement, is set forth by the committee as an urgent consideration.

According to the recommendations, ground-water data—information concerning the amount, position, and fluctuation—should be expanded by installation of 4,000 wells as base stations by the installation of 6,000 cooperative secondary wells; and by carrying on corollary geologic and hydrologic investigations, the latter to determine the most satisfactory location of wells and to apply data obtained to general water-resources problems in the various areas.

Thirty first-class stations and 250 second-class stations would be sufficient for the improvement of evaporation data. This would involve also the compilation of unpublished data, and at the same time research studies on the solar energy method of determining evaporation, and on evaporation from surfaces of snow and ice. Costs for evaporation data would be small, according to the advisory committee, with an initial amount of $35,000, dropping to $16,000 in the second and succeeding years.

For the collection of data adequate to an understanding of the quality of surface waters, it is recommended that 200 base stations be established for the measurement of mineral content, hydrogen-ion concentration, dissolved oxygen, suspended load and turbidity. Such stations should be located on sites of existing stream-gaging stations and should be maintained continuously for at least 10 years. At 100 of these base stations, regular measurements of water quality in respect to pollution should be made coincident with the chemical and silt measurements. At least 400 secondary stations are suggested, each of which should be operated for a 1-year period. Such secondary stations would be changed annually, with observations reported at intervals of from 5 to 10 years. The analyses would not be as detailed as those at the base stations, and their character would vary according to outstanding local problems of water quality, but their observations could be correlated with those taken at the base stations.

In closing that part of the report which deals with recommended standards and specifications for an expanded program for the collection of basic hydrologic data, the committee emphasizes the following: "It is only by establishing these expanded programs on a sound and scientific basis, taking full cognizance of the use of the data collected, making provision for continuing maintenance of a system of base stations, and using non-Federal cooperation at every practicable point, that a thoroughly useful body of basic hydrologic data may be obtained. With such a foundation of technical knowledge the Nation may look forward confidently to the effective and economical development and use of its water resources."

The appendix contains information, mostly in tabular form, concerning current programs for collection of hydrologic data, in the United States and European countries. Also included is the report submitted on November 6, 1935, by the special advisory committee on collection, compilation, and publication of basic data.

U. S. GOVERNMENT PRINTING OFFICE: 1937

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Office of Information, United States Department of Agriculture

Groups of Plants Valuable for Wildlife Utilization and Erosion Control. Circular 412. October 1936.

Eradication of Ferns From Pasture Lands in the Eastern United States. Farmers' Bulletin 687. Issued September 1915. Revised November 1936.

Game Management on the Farm. Farmers' Bulletin 1759. October 1936.

The Use of Bluegrass Sod in the Control of Soil Erosion. Farmers' Bulletin 1760. October 1936.

Woods Burning in the South. Leaflet 40.

Excluding Birds From Reservoirs and Fishponds. Leaflet 120.

Forestry and Permanent Prosperity. Miscellaneous Publication 247. November 1936.

Conservation Farming Practices and Flood Control. Miscellaneous Publication 253. October 1936.

Identification, History and Distribution of Common Sorghum Varieties. Technical Bulletin 506. July 1936.

Flow of Water Around 180-Degree Bends. Technical Bulletin 526.

Conditions Influencing Erosion on the Boise River Watershed. Technical Bulletin 528. October 1936.

Agricultural Experiment Stations

Agricultural Seed. Bulletin 410. Agricultural Experiment Station, Burlington, Vt. October 1936.

Canawa—A New Variety of Soft Red Winter Wheat. Bulletin 272. Agricultural Experiment Station, Morgantown, W. Va. June 1936.

Effects of Summer Cover Crops on Crop Yields and on the Soil. Bulletin 301. Agricultural Experiment Station, Gainesville, Fla. September 1936.

Factors Determining Type of Farming Areas in Nebraska. Bulletin 299. Agricultural Experiment Station, Lincoln, Nebr. May 1936.

Farm Irrigation Pumping Plants. Bulletin 237. Agricultural Experiment Station, State College, N. Mex. March 1936.

Fertilization of Alfalfa on Alkaline Calcareous Soils. Bulletin 154. Agricultural Experiment Station, Tucson, Ariz. October 1936.

Grazing Districts in Montana: Their Purpose and Organization Procedure. Bulletin 326. Agricultural Experiment Station, Bozeman, Mont. September 1936.

Hairy Vetch and Austrian Winter Peas for Soil Improvement. Circular 74. Agricultural Experiment Station, Auburn, Ala. August 1936.

Influence of Climate, Soil, and Fertilizers Upon Quality of Soft Winter Wheat. Bulletin 563. Agricultural Experiment Station, Wooster, Ohio. March 1936.

A Manganese Deficiency Affecting Beans. Bulletin 300. Agricultural Experiment Station, Gainesville, Fla. August 1936.

Montana Land Ownership. An Analysis of the Ownership Pattern and Its Significance in Land Use Planning. Bulletin 322. Agricultural Experiment Station, Bozeman, Mont. June 1936.

Movement of Salt (alkali) in Lettuce and Other Truck Beds Under Cultivation. Bulletin 152. Agricultural Experiment Station, Tucson, Ariz. May 1936.

Part-Time Farming in Indiana. Bulletin 410. Agricultural Experiment Station, Lafayette, Ind. April 1936.

Pasture Production and Management. Circular 15. Louisiana State University, Baton Rouge, La. January 1936.

A Planned Farm Program. Publication 187. Extension Service, University of Tennessee, Knoxville, Tenn. January 1936.

A Progress Report on the Production of Annual Legumes in the Panhandle of Oklahoma. Panhandle Bulletin 59. Agricultural Experiment Station, Goodwell, Okla. March 1936.

Propagation of Fruit Plants. Circular 96. Extension Service, University of California, Berkeley, Calif. January 1936.

Reaction of Zinc Sulfate with the Soil. Bulletin 298. Agricultural Experiment Station, Gainesville, Fla. June 1936.

Relation of Colloids in Soil to Its Favorable Use in Pise or Rammed Earth Walls. Bulletin 298. Agricultural Experiment Station, Brookings, S. Dak. March 1936.

Sheet Erosion Studies on Cecil Clay. Bulletin 245. Agricultural Experiment Station, Auburn, Ala. November 1936.

Soil Changes Resulting from Nitrogenous Fertilization. Bulletin 384. Agricultural Experiment Station, New Haven, Conn. June 1936.

Soybean Varieties for Hay, Seed, and Oil Production. Bulletin 334. Agricultural Experiment Station, Fayetteville, Ark. June 1936.

Storage and Germination of Seeds of Aquatic Plants. Bulletin 652. Agricultural Experiment Station, Ithaca, N. Y. July 1936.

Trends and Desirable Adjustments in Washington Agriculture. Bulletin 335. Agricultural Experiment Station, Pullman, Wash. July 1936.

The Two-Row Cultivator Converted Into a Weed Control Machine. Bulletin 303. Agricultural Experiment Station, Brookings, S. Dak. August 1936.

Value of Lime in a Two-Year Rotation on Sand Mountain. Circular 75. Agricultural Experiment Station, Auburn, Ala. October 1936.

Value of Winter Green Manure Crops. Bulletin 609. Agricultural Experiment Station, New Brunswick, N. J. September 1936.

Miscellaneous

Crops for Safe Farming. Agricultural Commission, American Bankers Association, Madison, Wis. 1936.

Major Land Use Problems. Tennessee State Planning Commission, Nashville, Tenn. March 1936.

Recommendations for the Improvement of Agricultural Conditions in Kansas. Mimeographed. Kansas State Planning Board, Topeka, Kans. November 1936.

Rhode Island Water Resources. Mimeographed. Special Report 9. Rhode Island State Planning Board, Providence, R. I. September 1936.

Water: Its Use and Control in Kansas. Kansas State Planning Board, Topeka, Kans. October 1936.

CONTOUR FURROWING FACTS

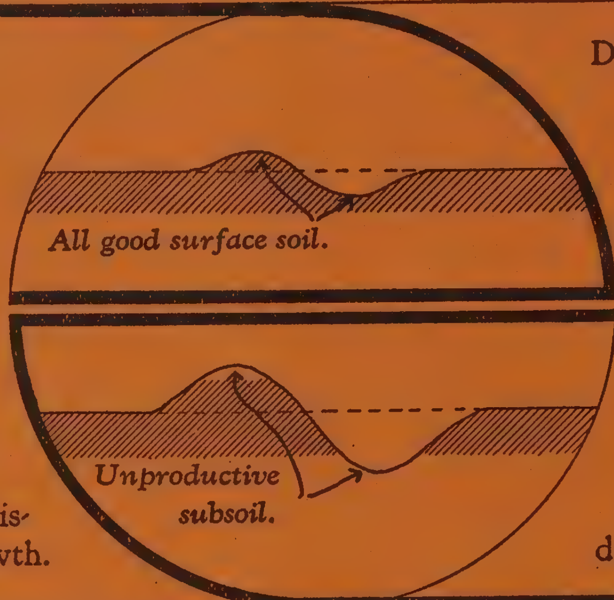
SHALLOW FURROWS

Natural-surface soil grows grass.

Buried grass will often grow through small furrow slice.

Shallow furrows close together will hold equally as much water.

Shallow furrows cause less disturbance of vegetative growth.



DEEP FURROWS

Subsoils grow weeds, if anything.

High ridges remain dry and seedling roots can't reach moisture.

Deep water in furrows is apt to drown grasses.

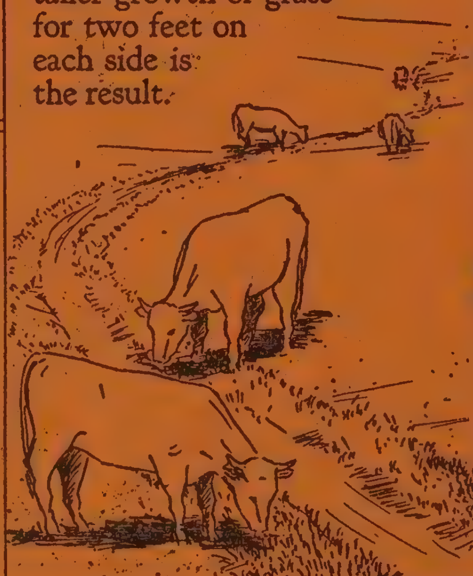
High ridges make mowing difficult.

EARLY HISTORY

At Abilene, Tex., in 1899 it was noted that the increased growth of grass on contour furrows was visible half a mile away 3 months after planting.

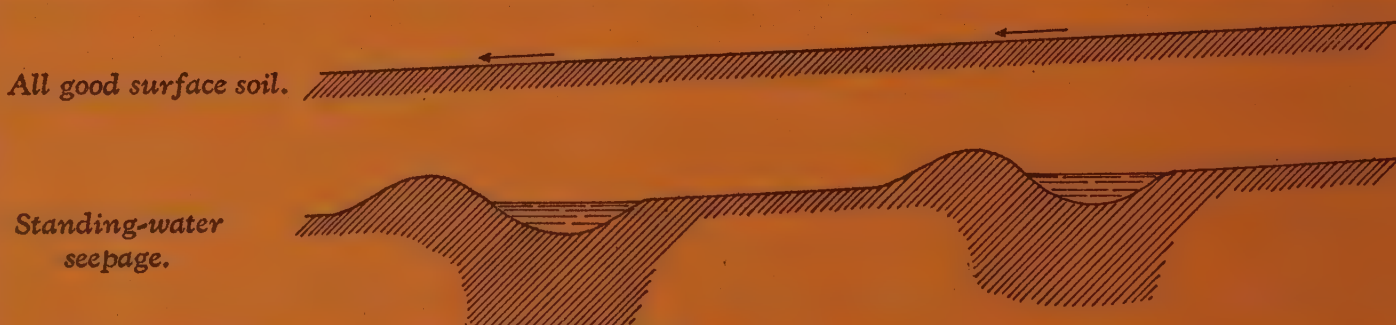
NATURAL EXAMPLE

Cowpaths that follow the contour hold water, and a thicker, taller growth of grass for two feet on each side is the result.



SELF SUSTAINING

Increased vegetation resulting from increased moisture, stops and stores yet more water, thereby forming a reserve against drought.



STANDING WATER SEEPS DEEPER INTO THE GROUND THAN RUNNING WATER

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

FEBRUARY 1937

The photograph from which this cover was drawn is reproduced on page 186

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BACK COVER FEATURE

Two Hundred Years in the Piedmont

SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. SOIL CONSERVATION seeks to supply to workers and cooperators of the Department of Agriculture engaged in soil conservation activities, information of especial help to them in the performance of their duties, and is issued to them free by law. Others may obtain copies from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic. Postage stamps will not be accepted in payment.

WELLINGTON BRINK — EDITOR

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

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ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

The C.C.C. and Soil Conservation in the Southwest

by
C.W.Granger

MORE than 300 years ago Coronado's Spanish conquistadores started north from Mexico City in search of Gran Quivira, about which stories of fabulous wealth were told by the Indians. One route followed was that through El Paso del Norte the Pass of the site of El Paso, Tex. In their early American conquests the Spanish soldiers were always accompanied by members of the clergy who hoped to establish missions and Christianize the Indians. As early as 1630 a few of the Spaniards settled along the Rio Grande near the present location of Ysleta and began farming operations. There they found a rich alluvial soil which they irrigated with water from the Rio Grande by means of a crude diversion system. Farming and stock-raising continued to be practiced in the vicinity of Ysleta and El Paso, but it was not until 1840 that a farming settlement was established in the Rio Grande Valley, above El Paso.

Flood Hazard Reduced

In 1904 about 39,000 acres in El Paso Valley, Mesilla Valley, and Rincon Valley were under irrigation, but there were no permanent diversion structures nor any storage facilities. Under authority of the Reclamation Act of 1902 feasibility of an irrgation project in the area was announced. The Bureau of

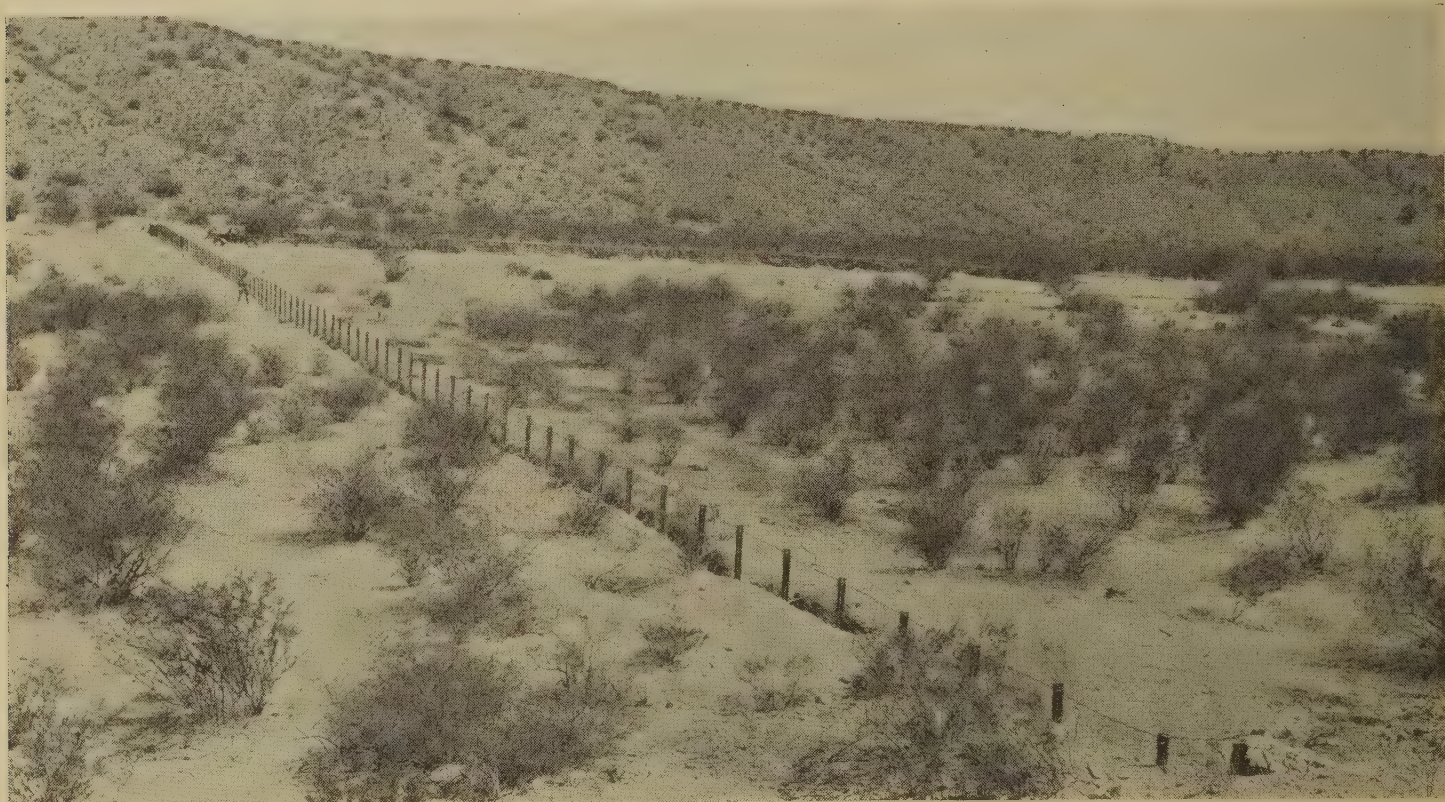
119285—37——1

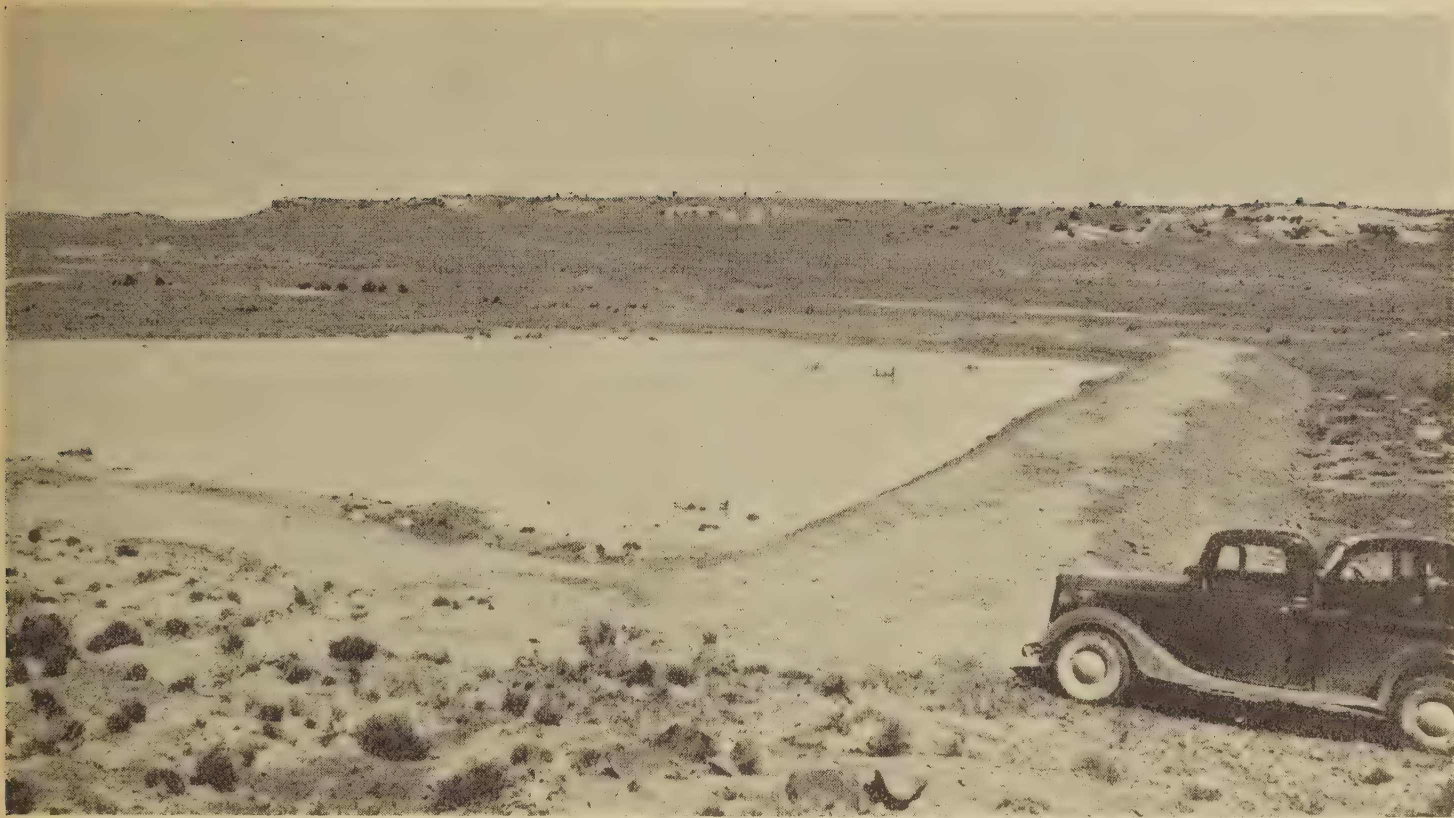
Inexpensive pole and wire riprap to prevent further erosion of highway roadbed.

Reclamation immediately began to plan for the construction of a storage dam and an adequate system of diversion structures and canals, though actual operations were not begun until 1910. Engineers approved a location 120 miles north of El Paso where today we have the Elephant Butte Dam and Reservoir which supplies water for the fourth largest Government irrigation project, and very materially lessens the flood hazard downstream. The dam and auxiliary construction units represent a total cost of slightly more than $15,000,000 and supplies water for 155,000 acres of land which is divided into about 5,000 farms. In 1934 the gross yield on this land was $76 per acre, a total gross yield of about $12,000,000 for the whole project. The principal crops are alfalfa and cotton; but stock raising, dairying, and fruit growing are important also.

Besides 26,108 persons who live on farms, there are 37 towns within the project area, the principal ones being El Paso, Las Cruces, Hatch, Fabens, Ysleta, Clint, and Mesilla Park. The total farm investment is $47,500,000 but that figure does not include the value of town and city property; utilities, railroads, and other industries; schools; highways; and other improvements. Besides the New Mexico State College of Agriculture at Las Cruces and the Texas State College of Mines at El Paso, there are many high

This rail and wire check and water-spreader extends 1,000 feet across Wyneam Canyon. It is one unit of a flood-control project in the Rio Grande district. It was constructed by the C. C. C. under supervision of the Soil Conservation Service.





Dam constructed by C. C. C. under direction of Soil Conservation Service, to provide water for stock. Rio Grande district.

Percolating log and rock dam to check flow until cottonwood and willow cuttings become established.

Small rubble masonry dam impounding water for stock and serving to check flow of flood water. Another structure in the Rio Grande district built by the C. C. C. under direction of the Soil Conservation Service.

schools and rural schools on the project, in all 87 scholastic institutions. There are 6 banks, 124 churches, and 23 railroad stations. Electric power from El Paso is available to all residents of the area. If it is ever considered advisable to produce power at Elephant Butte, it can be accomplished by the construction of another dam downstream.

Sedimentation Threatens

This immense reservoir which has a capacity to impound 2,638,860 acre-feet of water—enough to irrigate the whole project for 2 years even if there is no accumulation during that time—is in danger of having its value seriously impaired because of sedimentation. At this time, 20 years after its completion, the reservoir storage has been depleted by 13.84 percent through accumulation of silt. Due to overgrazing, a considerable portion of the Rio Grande watershed has been almost denuded of vegetative cover; as a result, hard rains, typical of the Southwest, wash into the streams a large volume of silt which is carried on down-stream to be deposited finally in Elephant Butte Reservoir.

Protection of the Elephant Butte project is one of the problems that faced the Service when it was created in 1933, and plans were made to determine possible remedial measures. It is believed that if vegetative cover can be brought back, only a relatively small amount of silt will find its way into the Rio Grande. In order to restore vegetation three things are necessary: Soil must be stabilized; moisture sufficient to germinate and nourish vegetation must be conserved; grazing must be regulated.

In the Rio Grande district some of the land that needs to be treated is privately owned; for control of grazing on this land cooperative agreements have been made with the owners. There are also several thousand acres purchased by the Resettlement Administration for the eventual use of Indians; the Indian Service is cooperating with the Soil Conservation Service to control grazing on this area. It is quite obvious that other control measures involve operations that require a large amount of labor if they are to be followed along a scale comprehensive enough to enable the Service to deduce rather definite opinions.

Ten Camps Established

Under the supervision of Hugh G. Calkins, regional conservator, Soil Conservation Service, eight C. C. C. camps were established in the fall of 1935 on the Rio Grande watershed; one on the Rio Grande proper at Las Cruces, N. Mex., below Elephant Butte Reservoir; three on the Rio Chama; two on the Rio Puerca; and two on the Rio Jemez. In April 1936 a camp was placed near Kingston, N. Mex., at the head of Perchas Creek, which empties into the Rio Grande below the reservoir. The three camps located below the dam are engaged primarily in flood-control work to protect farm and city property located below the dam from

(Continued on p. 173)

EIGHTEEN FARMERS SAY "WE'LL DO IT OURSELVES"

By Lyman Carrier [1]

The Soil Conservation Service and the Virginia State Extension Service decided during the summer of 1936 to test the possibility of spreading the benefits of soil conservation more rapidly over the State. Charlotte County was selected because the farmers there had shown sufficient interest in controlling erosion to organize a soil conservation association and purchase a terracing outfit. Charlotte County is typical of a large area of the southern Piedmont region of Virginia. Approximately 80 percent of the farming land has lost from one-fourth to three-fourths of its topsoil by erosion. Tobacco growing has been the main farming industry for many years; but of late there is a tendency toward a more diversified agriculture with increased livestock production.

Eighteen Farmers Selected

To start the program, the county agent, H. E. McSwain, selected 18 farmers scattered over the county and issued to them invitations to attend a soil conservation meeting. Seventeen responded. After it was fully explained to these farmers that all the assistance they might expect from the Government would be technical guidance and supervision and that they must themselves furnish labor, materials, seeds, fertilizers, and underwrite what terracing was necessary, they agreed to go ahead with the work. Later another farmer was added to the list, making 18 in all.

The next step was the making of soil, erosion, slope, and land-use maps for each farm. These were made by F. F. Nickels and D. D. Montgomery, of the Soil Conservation Service, with the help of draftsmen of project no. 2, Lynchburg.

Then came the development of farm plans. It was proposed to give these farmers complete coordinated programs covering a 5-year period, such as those embodied in the agreements drawn for the farm cooperators in the demonstration and camp areas. When completed, the plans were approved by the farmer, the county agent and his assistant, the extension agronomist, the S. C. S. conservationist, and the project manager.

There is nothing in these memoranda of understanding which is legally binding on either Government or farmer.

[1] State coordinator, Soil Conservation Service, Blacksburg, Va.

The 18 farms contained 4,596 acres, 2,241 acres of which was cultivated or in pasture, and the remainder woods, roads, or other nonagricultural land.

A regular crop rotation was established on each farm wherever practicable. Nine hundred and sixty-three acres are to be in general farm rotations and 333 acres in special tobacco rotations. Of these 1,296 acres, 420 are either entirely new rotations or improvements on the cropping systems which have been in practice in the past.

Eight of the farms had fields adaptable to strip cropping, and 315 acres are to be farmed after that method. This is a new feature in the community.

Eight hundred and eighteen acres are to be contour-tilled—another innovation locally. Two hundred and fifteen acres will be terraced.

The new plans call for 717 acres of pasture and 166 acres of permanent meadow; of these, 272 and 120 acres respectively are on lands to be retired from cultivation. Five hundred and seventy-three acres of pasture lands are to be reseeded, 604 acres limed, 123 acres treated with superphosphate, and 495 acres are to have an application of a complete fertilizer.

Croplands other than pastures are to have 403 acres reseeded, 1,337 limed, 65 phosphated, 1,282 treated with a complete fertilizer, and 125 manured.

Cooperating Farmers Furnish Materials

Of the 2,241 acres of croplands on these farms, the agreements call for special treatment for 2,025 acres. To carry out the agreements, the farmers must supply 14,045 pounds of a pasture-mixture seed, 2,538 pounds of hay mixture, 180 pounds of meadow-strip mixture (for terrace-outlet channels), 840 pounds clover, 1,900 pounds alfalfa, 1,436 pounds redtop, 4,095 pounds lespedeza, and 840 pounds orchard grass. The fertilizer treatments require 1,655 bags of 0–12–5; 2,864 bags complete fertilizer, 4–12–4; 264 bags 16 percent superphosphate, 2,476 tons of lime, and 336 tons of manure.

Wood Lot Improvement

As over half the area of these farms is in woods, it did not seem advisable to retire any of the land to forest planting. It is the intention, however, as soon as a forester is available for the work, to give these farmers instructions in wood-lot improvement, marking for them, on small areas of 1 or 2 acres, the trees which should be kept.

The responsibility for the future supervision of the program on these 18 farms rests mainly on the county agent and his assistants. One of the assistants, P. A. Robinson, is employed jointly by the Extension Service and the Soil Conservation Service to supervise the terracing operations. He will lay off the contour lines as needed, and supervise the construction. The technicians of the Soil Conservation Service will visit the county occasionally to confer with the county agent on the progress of the work and to assist the farmers whenever their services are needed.

The total costs to the Soil Conservation Service for this project to date, counting the actual time devoted to it, amount to but $728.50, with salaries and expenses of the extension workers estimated at only $600.

The accompanying statistical analysis and land-use maps of the H. W. Lawson farm in Charlotte County will serve to indicate what is being done by the cooperating farmers.

(Continued on p. 188)

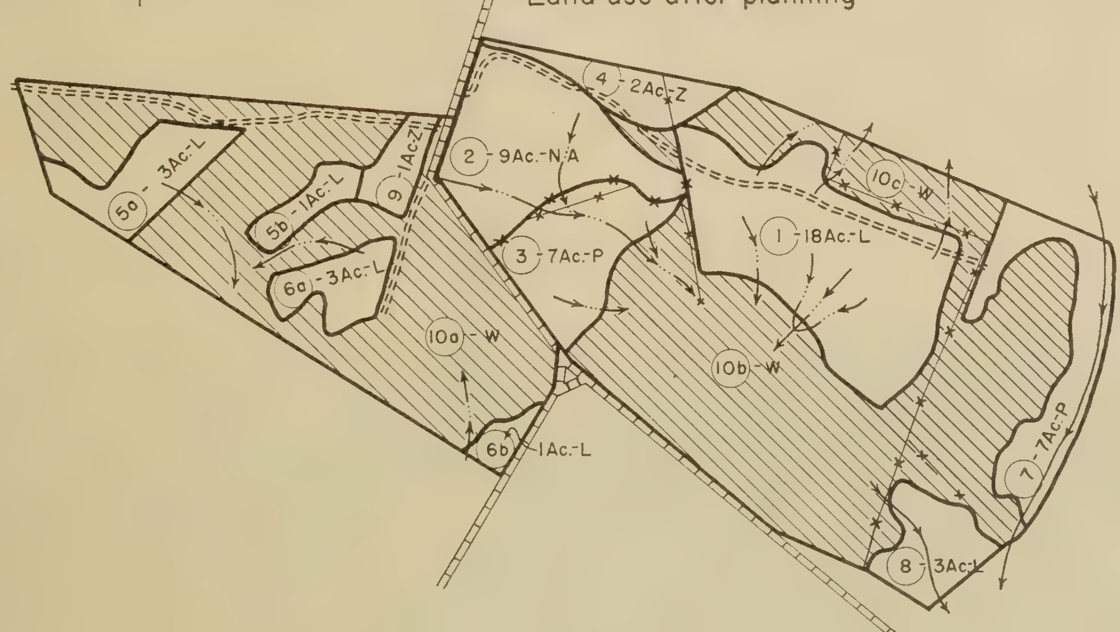
Cropping plan—H. W. Lawson farm

Field No.	Field Sec.	Acres	Before contract	New cropping plan and treatment: 1937	1938	1939	1940	1941
1		18	Idle, 8 acres Corn, 3 acres Tobacco, 3 acres Peas, 4 acres	Wheat Lespedeza Grass Corn, 3 acres	Corn, 6 acres Wheat, 6 acres Lespedeza Grass, 6 acres	Wheat Lespedeza Grass Corn	Lespedeza Grass Corn Wheat	Corn. Wheat. Lespedeza. Grass.
				Field to be divided into 3 6-acre fields for 3-year rotations as soon as terraced. 6 acres wheat to receive 10 tons ground limestone in fall of 1936 before seeding wheat; other 12 acres to receive 10 tons of ground limestone per 6 acres as they come into wheat. Corn to receive 300 pounds 4–12–4 fertilizer per acre. Wheat to receive 300 pounds 4–12–4 fertilizer per acre. Clover to be mixed with lespedeza and grass as land is limed and fertilized and will produce it. 0–12–5 fertilizer to be substituted for 4–12–4 fertilizer as soon as some clover and lespedeza is turned under.				
2		9	Corn (each year)	Lespedeza Grass	Lespedeza Grass	Lespedeza Grass	Lespedeza Grass	Lespedeza. Grass.
				Field to receive at least 1 ton ground limestone per acre and 200 to 300 pounds 0–12–5 fertilizer per acre. To be seeded with mixture of grass and lespedeza to be used as permanent meadow.				
3		7	Pasture	Pasture	Pasture	Pasture	Pasture	Pasture.
				In broom sedge and wild lespedeza, to be seeded in redtop, orchard grass, and lespedeza after fields 1 and 2 have been fertilized, limed, and seeded. Lime and fertilizer same as for field no. 2 or permanent meadow. Woodland to be fenced out of pasture.				
4		2	Truck crops	Garden, truck crops, etc.				
5	a and b	4	Idle	Tobacco	Wheat	Redtop	Tobacco	Wheat.
6	a and b	4	Tobacco	Redtop	Tobacco	Wheat	Redtop	Tobacco.
				By 1939 operator plans to clear sufficient land to run a 3-year rotation and if found desirable, allow Helena soil of field no. 5 to return to meadow. Clearing to be done so that fields are correctly sloped; and no steep land cleared.				
7		7	Idle Pasture	Pasture Bottom land	Pasture	Pasture	Pasture	Pasture.
8		3		To act as catch crop field with mostly corn until rotation is established. Use 300 pounds 4–12–4 fertilizer on corn per acre.				
9		1	Truck and garden					
10		75	Woods, roads, and other lands					
				1. The Government (S. C. S.) agrees to cooperate with the landowners in a woodland-management program and furnish a forester for technical supervision. 2. The cooperator agrees to protect to the best of his ability his woodland area from fire and improper grazing and cutting. 3. The Government (S. C. S.) agrees to mark 2 acres for a forest stand improvement demonstration on the farm.				

H. W. LAWSON FARM

Land use before planning

Land use after planning



LEGEND

A Land removed from cultivation for other use
C Corn
L Cultivated land
N Grasses or perennial legumes for hay
P Pasture - permanent
S Peas
T Tobacco
W Forest or woodland - old timber
X Idle land
Z Miscellaneous crops, vegetables, small fruits, etc.
(2) Field numbers

DOLLARS ARE SAVED, AS SOILS ARE SAVED, IN 12 NORTHEASTERN STATES

SOIL conservation dollars grow bigger—buy more terraces, diversion ditches, contour furrows, fences.

Projects throughout the United States prove not only that erosion can be controlled but that it is possible for the average farmer himself to undertake the conservation of his chief asset, the soil.

Cost reductions, revealed by carefully kept records in all regions of the Soil Conservation Service, are being brought about as a worth-while by-product of mounting efficiency and increased simplicity of methods.

Survey Points the Way

In response to an inquiry by this publication, Dr. A. L. Patrick, regional conservator for New England, New York, Pennsylvania, Delaware, New Jersey, Maryland, and West Virginia gathered reports from a number of projects and camp areas which point the direction which economy is taking.

Until June 1936 terracing as a method of controlling erosion and conserving moisture had never been used in any of the States of the Northeastern region. It was introduced by the Soil Conservation Service. Most of the personnel was unfamiliar with the construction of terraces and as a consequence the first costs were high. Many farmers soon became convinced of the effectiveness of this type of soil and water conservation and in every locality the practice has spread.

As the work increased, efficiency improved. In New Jersey the cost of terracing has been reduced 85 percent. In Maryland costs came down 75 percent. Present costs are still high, but are being rapidly reduced as operations expand.

Similarly, the cost of terrace outlets has been reduced 50 percent in New Jersey and 90 percent in Maryland. This is due in large degree to better planning of terrace projects and to more efficient execution of the work.

The cost of diversion ditches has been reduced from 75 percent in some places to more than 90 percent in others. This decrease is due primarily to greater use of equipment and power by both the Soil Conservation Service and the farmers.

The cost of fencing has been reduced 40 percent and that of tree planting 55 percent.

Closer Supervision

It might be well to note that the greater part of these cost reductions has been effected since the establishment of the regional office. This provided closer supervision, the benefit of assistance from more experienced personnel, and a more thorough coordination of the program.

Diversion ditch in Pennsylvania constructed by hand labor at a cost of 34 cents per linear foot.

A diversion ditch similar to that shown on opposite page, constructed by power machinery at a cost of 2½ cents per linear foot.

A factor in the originally excessive costs was the necessity of using large numbers of workers who were untrained and inexperienced in this type of work, mostly C. C. C. and W. P. A. employees.

The contour furrowing of pastures has long been recognized by the Soil Conservation Service, for its value in soil and water conservation. It is only within the past 6 months, however, that strides have been made toward more economical methods of doing the work. Within this time the average cost of contour furrowing throughout the region has been reduced 62.5 percent—a very material saving to the Government.

A Pennsylvania Project Reports

A REVIEW of some of the savings effected on various projects, operating under a variety of conditions, may be of interest.

At Sligo, Pa., costs of controlling gullies have been cut by the substitution of diversion ditches for expensive check dams, where that is feasible. The water is diverted through ditches to a satisfactory outlet, or is spilled onto a pasture where it really does some good. By using machinery, the expense of constructing diversion ditches has been reduced from 58 cents per foot to 36 cents. This is considered a big improvement over the former hand method.

Woodland specialists here have brought down the cost of building fences from $2.90 per rod to $2.01 per rod, by the simple expedient of tacking wire to trees.

A slight reduction in cost of planting has been effected through the use of contour furrows. The furrows act as small diversion ditches in controlling run-off.

Within the watershed a trend toward strip cropping is evident. Many farmers not now under cooperative agreements are following the suggested revised layout on their farms rather closely. Probably one-third of them have installed strip cropping.

Many of the farmers outside the watershed have a very hazy conception of the work being done. Where there is strip cropping on the contour it is usually a practice that has been followed for a number of years and as a result of the farmers' observations.

It is unlikely that there will be a material spread of conservation practices until the revised layout on the farms of cooperators becomes completely evident, which in instances will not be until the crop years of 1937 and 1938.

During the later summer the camp received a grader and terracer, which were immediately put to work constructing diversion terraces. Up to that time the cost had averaged 34 cents per lineal foot. That figure through the use of the grader was reduced to 20 cents. For those diversion terraces that have been made largely with the machine the cost has ranged

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from 1 to 5 cents per lineal foot, depending on the amount of hand work necessary.

A Table That Tells Much

The following summary sheet shows a general reduction of costs in all types of work over a period of a year and a half. While this may not appear spectacular, it nevertheless shows a continuous improvement in efficiency of operations carried on by this camp.

advantage of selecting enrollees especially for the work, when that can be done.

"It is of interest to note how the work is spreading among farmers not under contract. On a farm owned by W. H. Shoaff and operated by S. R. Main, strip cropping has been established on 13 acres and started on 15 acres more. Four acres of pasture have been treated with seed, lime, and fertilizer; 6 acres of alfalfa have been started; 6 acres of woods have been protected from grazing which formerly were pasture.

Item	Nov. 30, 1935		May 29, 1936		Nov. 28, 1936	
	To date	Man-hour per unit	To date	Man-hour per unit	To date	Man-hour per unit
Tile ditch	2,333 feet	1	3,376 feet	0.8	11,181 feet	0.5
Diversion ditch	5,402 feet	1.2	6,272 feet	1	11,712 feet	.3
Diversion terrace	8,324 feet	1	9,274 feet	1	28,539 feet	.6
Bank sloping	866 square yards	2.2	3,950 square yards	.6	17,240 square yards	.3
Riprap	185 square yards	8.1	217 square yards	6.7	437 square yards	4.8
Seeding or sodding	313 square yards	3	313 square yards	3	1,039 square yards	1.1
Temporary dams	30	4	30	4	3	4
Contour strips			1,808 acres	.9	6,872 acres	.7
Lime quarry set-up			2,853 cubic yards	8.2	5,009 cubic yards	4
Lime quarried			1,472 tons	2.3	3,802 tons	2.
Lime pulverized			195 tons	2.5	1,804 tons	2.2
Lime hauled			195 tons	1.1	1,804 tons	.9
Maintenance, bank sloping			311 square yards	.4	761 square yards	.2
Maintenance, diversion terrace			2,297 feet	.1	7,947 feet	.08
Fence constructed	1,785 rods	5.7	3,580 rods	4	8,818 rods	3.2
Posts or braces cut	2,427	1	4,855	.8	10,625	.5
Fence removed	713 rods	2.4	1,292 rods	1	2,330 rods	.5
Trees planted	114,250	.05	142,775	.04	204,550	.04
Seed collected	6,768 pounds	1.3	6,768 pounds	1.3	11,630 pounds	.7

This improvement can be generally attributed to an increased knowledge of local conditions gained through contacts with varied problems encountered as the work progressed as well as to the experience gained by the technical and supervisory personnel.

The summary sheet is based on data taken from the weekly work reports for the last week in November 1935, the last week in May 1936, and the last week in November 1936, showing the amount of work completed to date and the average man-hours per unit.

Employees Better Trained

THE manager of the Vandergrift, Pa., project ascribes reduced costs in putting soil conservation practices into effect to the use of machine instead of hand labor, to greater experience on the part of the supervisory staff, and to better job training given to C. C. C. employees who are doing the work.

The cost of building terraces on this project has been reduced from 23 cents to 8 cents per foot by the use of a terracer.

"In tree planting and fence building," he says, "costs of late have been reduced not so much by a change in method as by the fact that camp enrollees were better trained at the start. This illustrates the

"Donald Culp, one of our employees, has instituted some of the Soil Conservation Service practices on his father's farm. These include strip cropping and tree planting."

Fencing in West Virginia

AND from Moundsville, W. Va., comes further information on how efficient conservation is being achieved at less expense:

A more efficient operation of work crews has reduced the cost per rod of fencing by about 15 percent. The quality of the fence is high. The reduction is due to increased labor efficiency.

A 25-percent saving in the cost of construction of contour furrows has been achieved.

The use of machinery suited to the construction of diversion ditches has reduced the cost of this work by about 40 percent.

The permanent check dams now being constructed are proving more effective than those which were being built on July 1 but the cost of construction has been reduced by about one-third. The same is true of the temporary dams. These are now being built so that the cost for materials is greatly reduced and the principal charge is for labor. The saving amounts to nearly 30 percent.

There has been a 33.5 percent reduction in overhead costs for farm planning by the technical men of the staff. The men have increased in efficiency as they have gathered experience.

It is felt that costs on this project have been running at a rather conservative figure but the fact that they have been uniformly reduced without loss of efficiency during the past 6 months indicates that future improvement may be expected.

Plans Laid on Rainy Days

SOME interesting suggestions are found in these notes from the project at Waynesboro, Pa.:

Cost of laying out strips has been reduced by discussing the layout of strips with the farmer, with the help of a penciled copy of the revised land-use map. Increased experience of the W. P. A. strip-cropping crew allows them to measure more accurately the distances on the map, so that the men who work with the farmers can plot the finished map on rainy days.

The use of a plow supplemented with the V-drag has reduced the cost of diversion-ditch construction, as this equipment requires less hand labor.

By the use of a plow, a ditcher, and other machinery, the cost of bank sloping has been reduced considerably. The cooperators' tractors and horses are employed wherever possible.

The cost of removing outcropping limestone for pulverizing has been lowered by using a tractor and grab hook on chain for pulling rocks out of the ground so that they can be pounded into movable size by C. C. C. labor.

Three farmers in the Waynesboro region were led by the demonstration to install strip cropping in 1936. Approximately 200 acres of land have been treated thus on the farms of H. G. Benedict, Robert Ridenour, and Dan Miller.

New Type of Ditch Developed

SIMILAR progress is observed on the Hagerstown project, in the neighboring State of Maryland:

Prior to July 1936, diversion ditches built to an adequate cross section, with comparatively steep side slopes, were employed to divert surface run-off from the heads of gullies and to remove accumulated surface water. These ditches were in some instances difficult to cross with farm implements and required considerable hand labor to construct. This type of ditch was under construction during June 1936 and was costing 56 cents per linear foot.

During the month of June the project developed the so-called diversion terrace, in the hope of lowering costs and increasing the adaptability of ditching to farm operations. To replace the old type of ditch and develop a sounder control measure, utilizing the beneficial qualities of the diversion ditch, terraces were designed and constructed having sufficient channel capacity behind a comparatively low ridge to accommodate maximum run-off from contributing drainage areas. They utilize a channel grade that would develop a nonsilting, and at the same time a noneroding, velocity.

These diversion ditches were of the broad-base type, easily crossed by farm machinery. They were constructed wholly by a tractor and terracer. They were seeded to permanent grass and a permanent grass strip remains above each terrace as a filter to protect against further channel silting.

This type of diversion terrace has met with favor among cooperators and it has been used not only around gullies but above potential gully areas and on lines of division between some strips in strip-cropped fields.

Because of increased efficiency of machine operators and judicious choice of locations for use, the cost of this work has reduced progressively each month since June, as shown in the following table.

Month	Linear feet of diversion terrace	Cost per linear foot
June	3,125	$0.56
July	3,990	.36
August	3,936	.17
September	1,900	.092
October	1,183	.055

A total of 14,134 linear feet was constructed on 9 cooperating farms.

This is a notable case of cost reduction through an improvement in engineering practices and the adaptation of a new design to meet local conditions. A 90-percent cost reduction on one form of conservation operations in less than 4 months' time is certainly a worth-while achievement.

In the Harwood camp area timber flumes constructed of native logs and castoff sawmill slabs protected with tar roofing paper have been built in gullies up to a depth of 30 feet in lieu of concrete or other masonry structures. Vegetation has been established in these gullies and around these flumes and this cheaper method of control of large gullies has been successfully demonstrated in this area.

This method can readily be adopted by farmers for the protection of their fields, since the cash outlay for materials is very low compared with the benefits derived.

A Combination That Pays

OVER in New Jersey the story of increased efficiency with increased economy continues:

"We have adopted some measures which we think will control erosion and which can be installed in lieu of more costly and extensive procedures", says the project manager. "Possibly the biggest improvement has been to combine strip cropping with diversion terraces, in place of the more costly complete terrace system. The first cost of installation is greatly reduced, and we believe that the combination will control erosion as effectively as a complete terrace system.

"Another practice which is reducing costs is the use of natural terrace outlets wherever possible. We have discontinued board or stone spreaders and are using sod spreaders with good results.

"Noncooperating farmers are beginning to use sodded watercourses, and some are cultivating their crops across the slopes, if not using actual contour tillage. Formerly they cultivated up and down hill."

Planting Iron Used

LAST fall on the Freehold, N. J., project all planting and seed spotting was done by planting irons. The sandy soil of project area 3 and camp area 2 lent itself to this practice. The iron used consisted of a wedge-shaped head and a pipe handle 52 inches long, the assembled implement weighing about 15 pounds. The two dozen such irons made at a local foundry for $1.13 each, paid for themselves in one day. At the time this report was made more than 75,000 trees had been so planted.

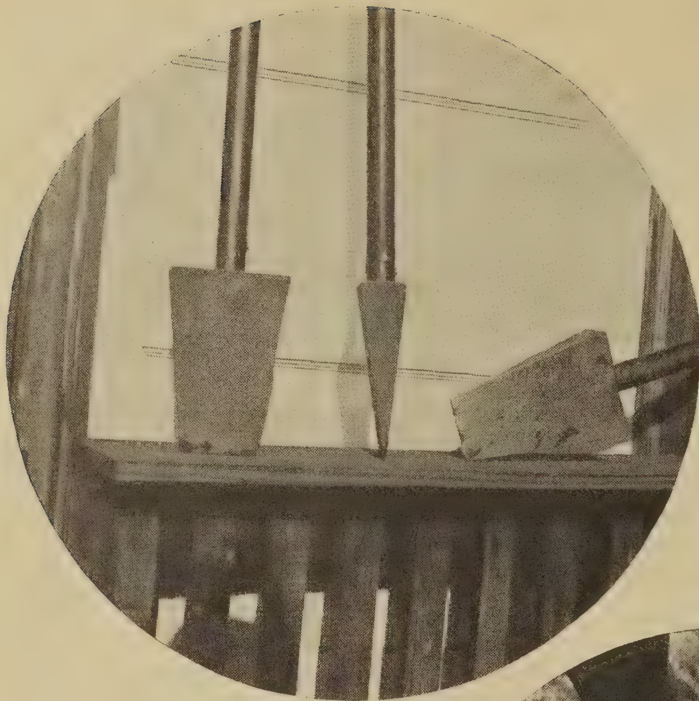
Use of these irons cut the cost from 5.4 man-days per 1,000 trees to approximately 2.6 man-days, the cost per 1,000 being reduced from $26 to slightly less than $12.

"While this iron is not applicable to all kinds of soils," it is pointed out, "the possibilities of its use should not be overlooked. We found it equally efficient in planting all our coniferous stock, locust, and even red oak and chestnut."

New York Farmers Follow

SOIL conservation practices are spreading in the vicinity of the Bath, N. Y., project. One farmer constructed a diversion ditch 700 feet long after it was laid out by an S. C. S. engineer. The cost to the farmer was 3 cents per foot.

Another farmer, a cooperator, and three noncooperating neighbors, excavated and hauled to their farms more than 100 cubic yards of marl, following demonstrations by the S. C. S. The cost approximated $1 per ton of lime, delivered to the farms.



Planting irons have sliced seed-spotting costs in half on the Freehold, N. J., project. The pictures show some of these irons and illustrate their use.

In some instances strips have been fall-plowed by noncooperators. They were not always on the contour, however, reflecting the need for developing an inexpensive farm level adapted to field use.

Many farmers have fertilized their pastures, as a first step toward their improvement. This they have done as a result of watching the farms of cooperators, who started doing this in the spring of 1935.

Attica Work Watched

The Attica camp has recently been visited by various interested groups, including the county agents of western New York and the supervisors of Wyoming County. Eagerness to adapt the project practices is evinced by numerous farmers several miles distant, numbers of whom are asking that a county conservation agent be employed to help them in their efforts to conserve soil and water.

The manager of the Bath project cites very considerable reductions in the cost of constructing diversion ditches in the project area and in two associated E. C. W. camp areas. The very low cost of 8 cents per lineal foot of ditch has been attained in one camp area. Tree-planting costs have been materially reduced.

Some Ideas That May Help

"Pointers" on cost reduction are enumerated as follows:

1. Biweekly field inspections by project staff members and State coordinating staff.
2. Periodic tours to stimulate interest and encourage better practices and education.
3. Careful accounts and comparisons, to keep field men conscious of the necessity of low costs and high efficiency.
4. Preliminary training, lectures by technical men to foremen. preliminary visits to job by technical men and foremen, planting schools for foremen, training on proper use of tools and other equipment.
5. Keeping same workmen, so far as possible, on types of work for which best fitted.
6. Planning travel schedules of trucks, etc., in advance to avoid excess travel and loss of time.
7. Informing all camps as to improvement of practices elsewhere.
8. Using large crews (25 men each), which may be subdivided into smaller units.
9. Feeding men in field, to avoid loss of time, excess travel, etc.
10. Preliminary planning by forester, so that trees may be ordered by the truck load and quickly heeled in on farms, with little travel from area to area.
11. Preliminary planning, to avoid travel on bad-weather roads.
12. Use of work orders, enabling foreman to know full particulars as to nature of job, location of job, and labor, materials, and equipment required. Foremen's reports not in reasonable conformity with estimates may then be given immediate check and analysis.
13. Placing definite responsibility for planning and executing work in specified area.
14. Holding weekly staff meetings to discuss problems, coordinate work divisions.

Versatility Encouraged

In the Lisle, N. Y., camp area the drift has been away from specialization. That is, there is no "fence crew", no "brush crew." Experience there indicates that specialization is not essential to efficiency. With comparatively few types of work to be done, a good crew soon becomes expert at a variety of tasks.

When a farm is released for work a foreman is assigned who is expected to handle the entire operations on it. The farmer has but the one foreman to deal with, and when one operation is finished the crew goes immediately to another on the same farm. This saves in time and transportation, makes for economical distribution of labor, and for better relations with the farmer.

The evidence points to more care on the part of nearby farmers in plowing and planting on the contour than in the past—a step definitely in the right direction.

Another List of Suggestions

ON THE Chenango Valley project at Norwick, N. Y., again we find costs diminishing. As a result of the experience accruing there, the project manager is enabled to advance these suggestions:

1. Have sufficient equipment at hand, properly maintained.
2. Encourage farmers to supply more of the labor and materials.
3. Reduce the amount of relief labor, weeding out the inefficient, and retaining small crews of capable men.
4. Employ small crews to bring down the expense of fencing.
5. Save by using experienced foremen and laborers, who are acquainted with the work and interested in it.
6. Sign enough agreements ahead so that work may be laid out for the most efficient use of labor and equipment.

THE C. C. C. AND SOIL CONSERVATION IN SOUTHWEST

(*Continued from p. 164*)

inundation of floods caused by rapid run-off from barren drainage areas.

Enrollees in these 10 C. C. C. camps, under the supervision of technical men, have accomplished voluminous work which already has proved effective for soil and water conservation and revegetation. They have worked a total of 297,652 man days (to and including Sept. 30, 1936) to complete work as follows: 14 large impounding dams with a total volume of 75,000 cubic yards together with 49 small reservoirs have been constructed; these serve a dual purpose as they not only impound water for stock but also help to control floods. Fifty-four thousand rods of fence have been built to keep stock from range until it is ready for grazing. There are 900 miles of contour furrows to hold water where it falls and thus check erosion and conserve much needed moisture for vegetation. To control gullies 30,000 check dams have been built, 19,633,000 square yards of banks have been seeded or sodded, and 407,000 trees have been planted. There have been constructed 123,000 lineal feet of ditch to divert water from gully heads and to spread it where needed for vegetative growth. Some 150,000 acres of public land have been rid of objectionable rodents, at least for the time being; and a topographic survey has been made of 49,000 acres. A total of 1,542 tons of stone for structures and riprap have been quarried and hauled. A million square yards of stream banks have been protected with jetties, riprap, and planting. Approximately 35,600 cubic yards of earth, stone, brush, and like materials have been used to make water spreaders to prevent the concentration of run-off in narrow channels. With flood prevention as the objective, 300,000 square yards of stream banks have been cleared and cleaned. In addition to regular field operations C. C. C. enrollees have engaged in fighting fires, in relieving flood conditions at Las Cruces, N. Mex., and in assisting to meet other emergencies.

If the Soil Conservation Service and the C. C. C. continue to cooperate in the Rio Grande district, it is felt that measures for materially retarding the siltation of the Elephant Butte Reservoir can be effectively demonstrated, and the economic usefulness of that important project prolonged.

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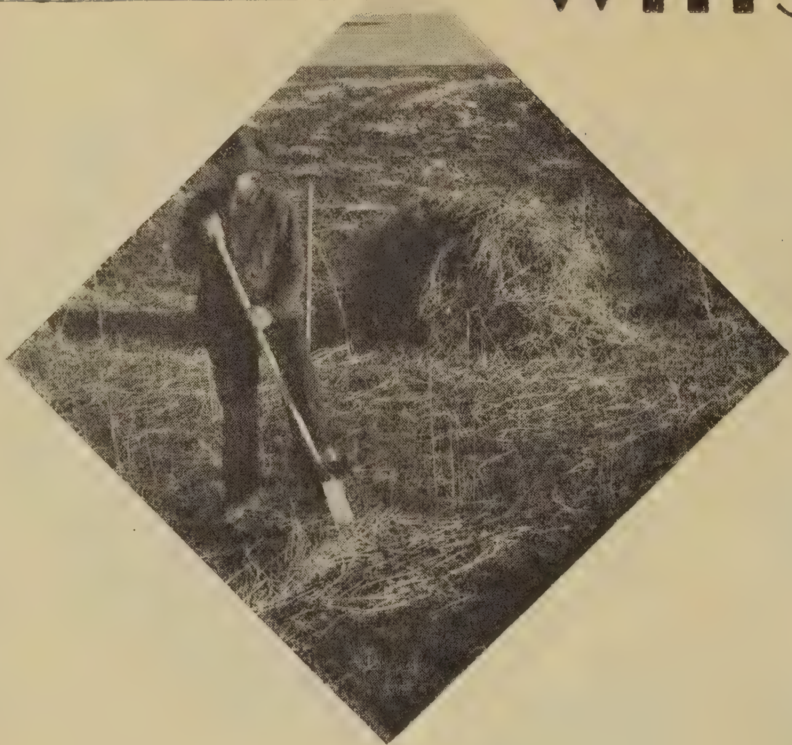
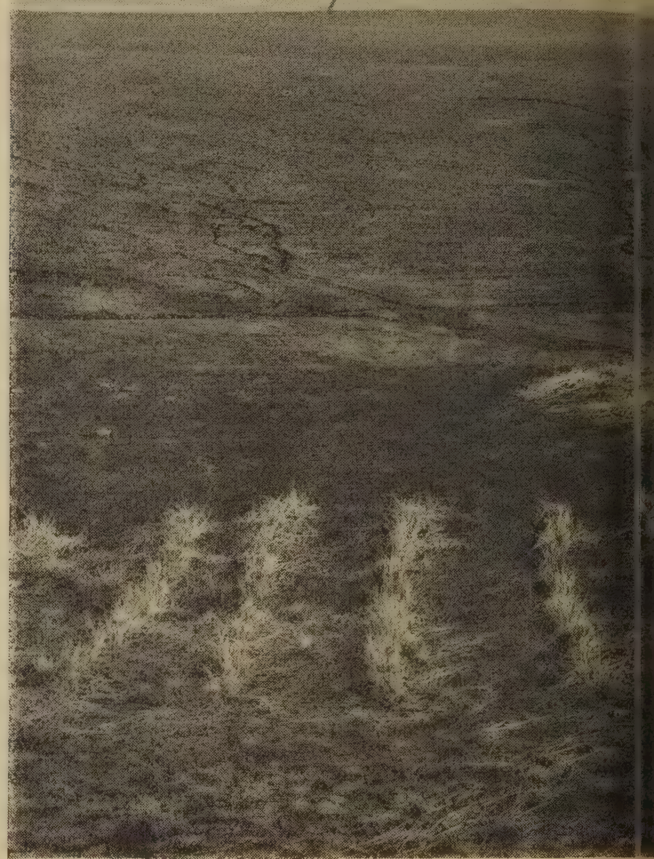
WHISKER DAMS

by C. Edwin Hill - D...
Soil Con...





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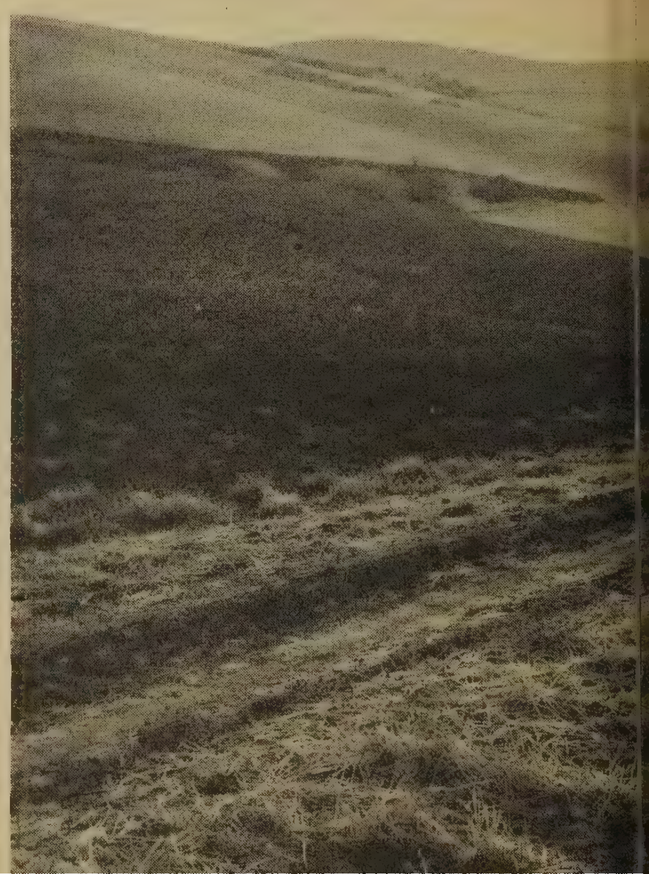

WHISKER dams have helped smooth out the gullies in Oregon. They have given the grass a chance to grow and while they were at that job they picked up a lot of silt and held it with the soil. Moreover, they performed this job with the materials at hand, requiring the use of but one implement—the old-fashioned spade. Other than the wielding of the spade they made very little demand for labor on the part of the men who put them in. A little history may serve to show how whisker dams established their worth.

Whisker-Dam History

The first scheme used to plug a gully was to build a series of dams across it so that silt would accumulate and ultimately fill the gully. The next was to smooth out the gully by filling in behind and even over the top of the dams and, immediately afterward, to start the grass cover. However it developed that during the long, rainless summer the grass was barely able to establish itself, and when fall came with occasional heavy rains these smoothed-out gullies frequently were washed out again by a swift flow of water and the new stand of cover destroyed. It was apparent then that some additional device was required to slow up flow and protect the grass.

Whisker dams were put in and they proved successful. Constructed across the gully and well up the side banks they stopped the water on its downhill course and prevented its escaping around the ends.

the NORTHWEST

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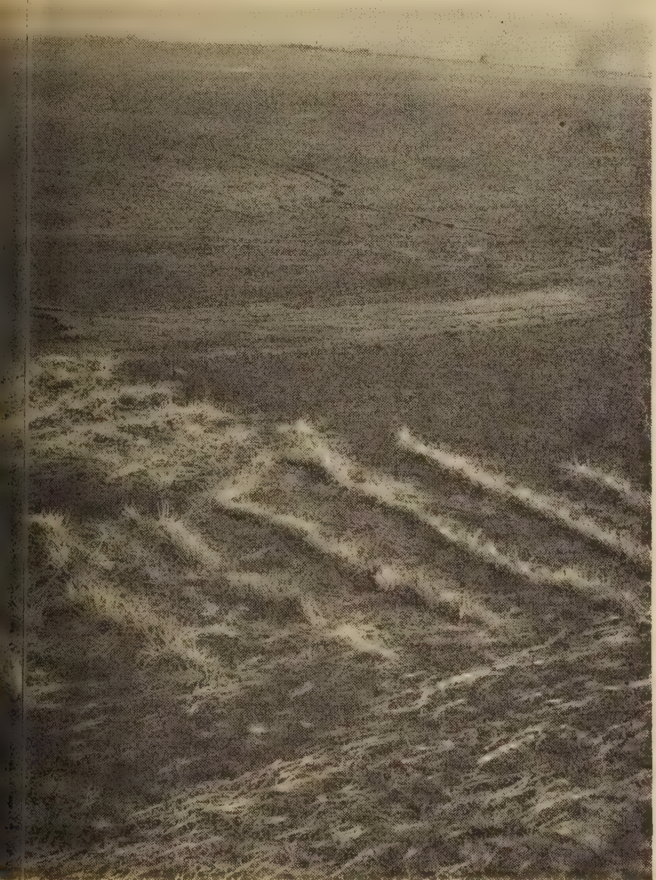

th "*whiskers*" *with a spade.*
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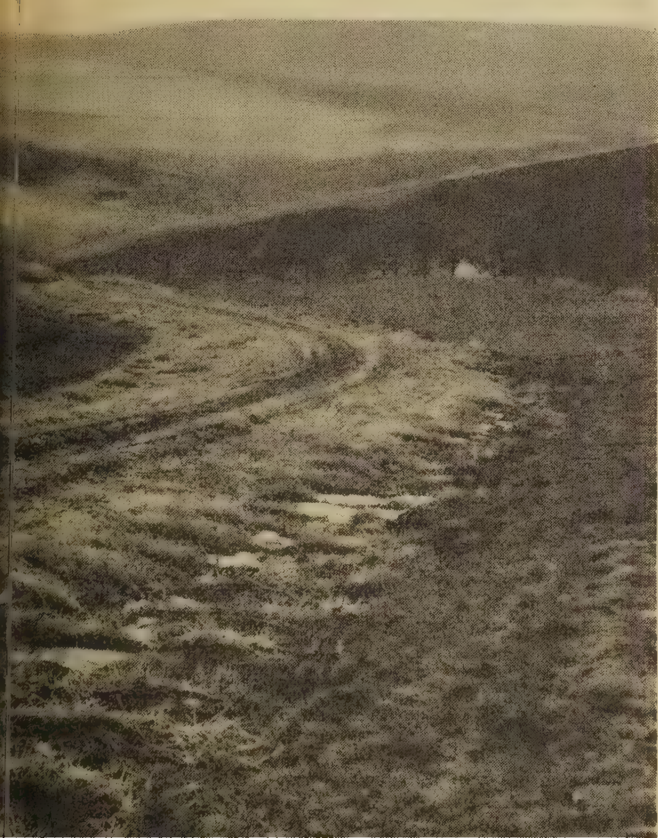
tt *impounders of water and silt.*



The construction of whisker dams is simple: Take an old-fashioned, square-nosed spade and sink it in up to the handle. Move it back and forth until a little V-shaped trench is formed. Do this until you have a trench across the gully. (Do not try to use a round-pointed shovel; it won't work.) Next, cover the trench with straw, and with the square-nosed spade press the straw down into the trench. Close the trench and pack the dirt in it by shuffling along with the upright whisker dam between your feet.

While the Grass Grows

These dams perform several functions. They are built primarily to slow up the water on its pell-mell course down the gully and thus prevent washing out of the new grass seedlings. While the water hesitates, a more plentiful supply of it soaks into the ground and whatever burden of silt it carries is dropped behind and into the dams.

Whisker dams had a test in March 1935 when the winter snows were taken off rapidly by warm temperatures and heavy rains. In spite of the heavy run-off, not one of them cut out.

Understructures Eliminated

Furthermore, these water walkways may be used to hold the soil in gullies while vegetation is established without the larger understructures being present at all, thus cheapening the control of gullies. With the understructures eliminated, except in some

(Continued on p. 180)

MECHANICAL INGENUITY SPURRED BY PROBLEMS PECULIAR TO SOIL CONSERVATION

By Gerald E. Ryerson [1]

IN various projects and camps many special tools have been devised which make it possible for the field work of the Soil Conservation Service to be done much more efficiently. Both major and minor pieces of equipment have undergone changes to fit them to particular tasks and to local conditions.

Probably more different kinds of sod cutters have been constructed than all other types of machines. At least two-thirds of all camps and projects contacted have reported some particular form of sod cutter.

Sod cutters are small tools and yet when the large amount of sodding which is done by the Service is considered, it is obvious that these small increases in efficiency effect large savings.

At the present time it appears unlikely that a sod cutter will be built which will work satisfactorily under all conditions, this owing to the extreme variations encountered in soil and in sod.

To date two general types of sod cutters have been developed, each having its own advantages. Since it is probable that a great amount of improvement can be made on many of the cutters now used, an example of each type is shown, with the fundamental characteristics which all cutters must have to work properly.

Sled Type Has Rolling Coulters

The sled type cutter is used most commonly. Plans for one of the better examples have been submitted by the project at Mansfield, La.

Undoubtedly, other projects have designed cutters which work as well. This, however, is chosen for description because it is simple, well built, and essentially correct in principle.

Although the plans as shown are self-explanatory, it is considered advisable to point out the rolling coulters which cut the sides of the sod strip ahead of the blade. The use of coulters in this position is very advantageous, particularly when there is any dead material in the grass. The knife is attached to the inside of the runners, thus allowing the sod strip to rise over it without wedging. The knife is symmetrical; that is, the cutting edge slopes each way from the center of the blade. There is no particular advantage in having curved blade—a pointed blade with slightly rounded point is satisfactory. The sides of the blade should slope back from the point at an angle of about 30°. The runners as shown are made from channel iron, but any hard wood would be equally as good.

Attachment for Stiff Sod

Also shown in the plan is an attachment whereby boards can be fastened to the blade and drawn under the sod as it is cut. Boards 1 by 10 inches and 8 feet long are used with this machine. In operation, the procedure is as follows: A strip of sod 8 feet long is cut, the strip is broken just back of the cutter, and the board is removed and loaded onto the truck with the sod on it, then another board is attached to the cutter and the process repeated. This system seems to be extensively used in region 4. It can be used only where the sod is stiff enough to push itself along the board.

Roller-Type Sod Cutter

Another type of sod cutter, which for lack of a better name will be called the roller type, has been developed by the project at Spring Valley, Minn. This cutter has no runners of any kind. The depth of the blade is regulated entirely by a 2-inch roller which rolls on the surface just ahead of the cutting edge. As shown in the sketch, two coulters which cut the ege of the sod strip are welded to the ends of this roller.

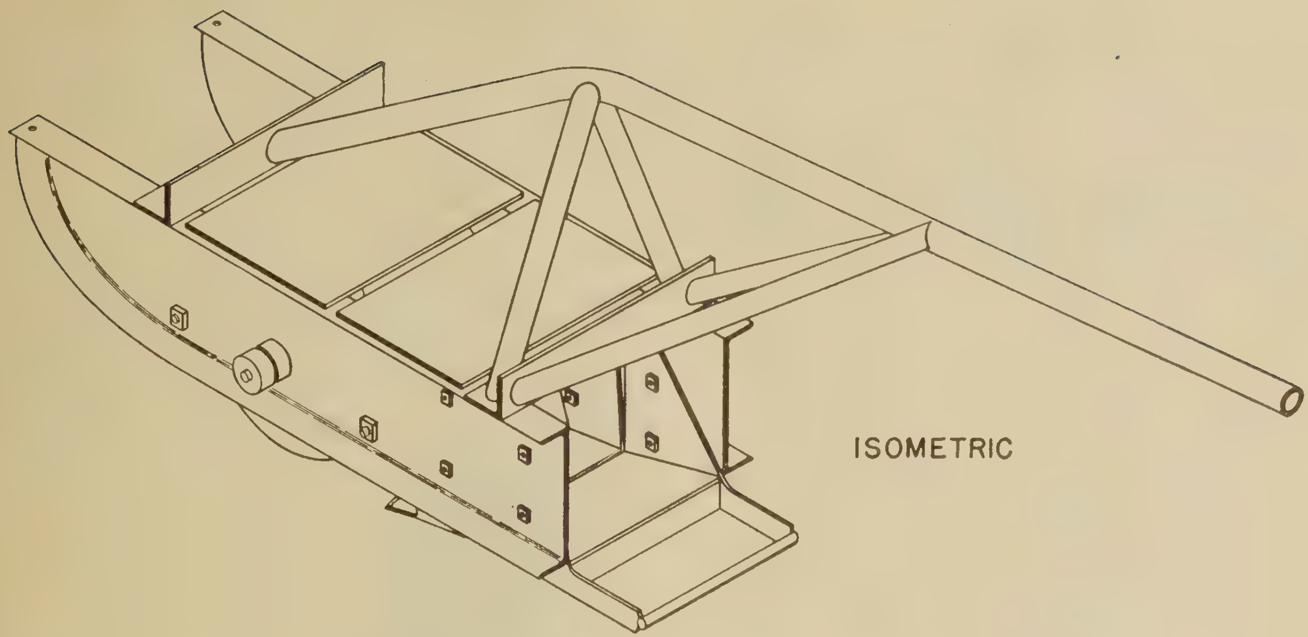
The blade on this machine is very similar to that described above except that it has one additional desirable feature. The cutting edge extends one-half inch outside the vertical sides of the knife. This allows small roots, etc., which become "hair pinned" over the cutting edge, to slide off the end without clogging in the corner.

Cuts at Uniform Thickness

This cutter also has two very distinct advantages for some localities over the sled type. It follows the irregularities of the ground surface much more closely, thus making it possible for the sod to be cut at a uniform thickness—a feature which is very important when the sod is to be used in "solid sodding" a water

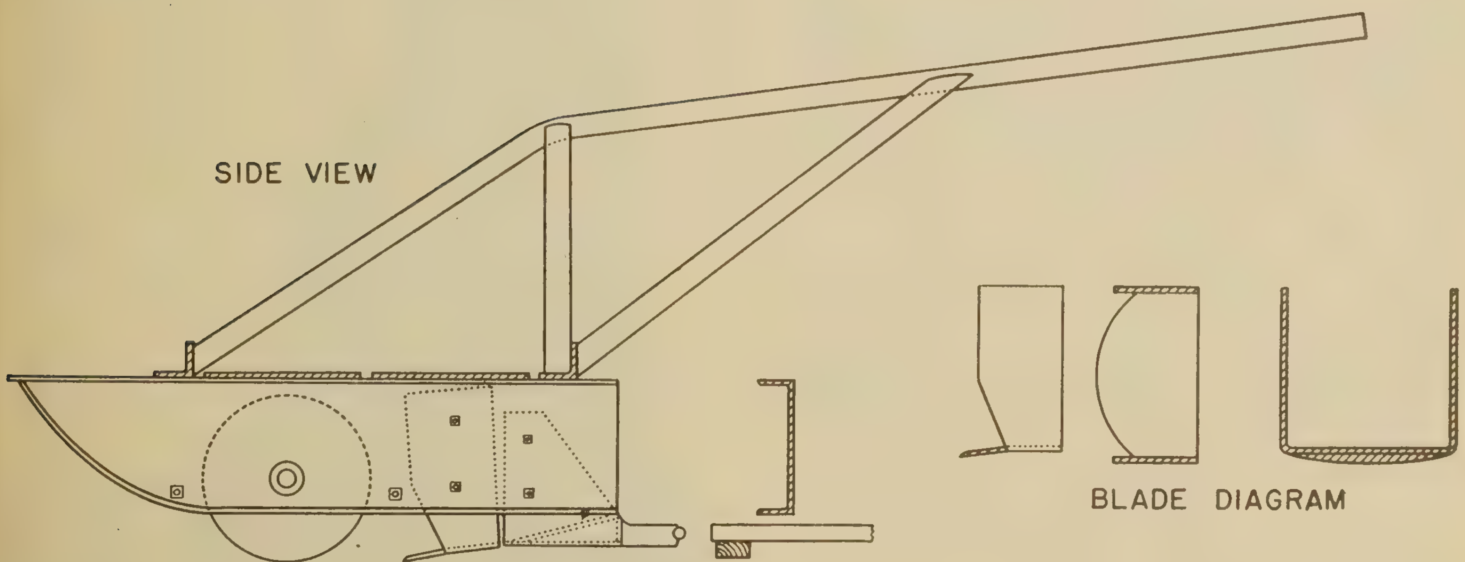
[1] Agricultural engineer, Soil Conservation Service, Washington, D. C.

SOD CUTTER



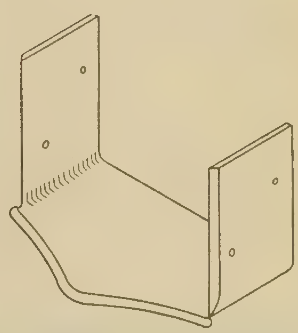
ISOMETRIC

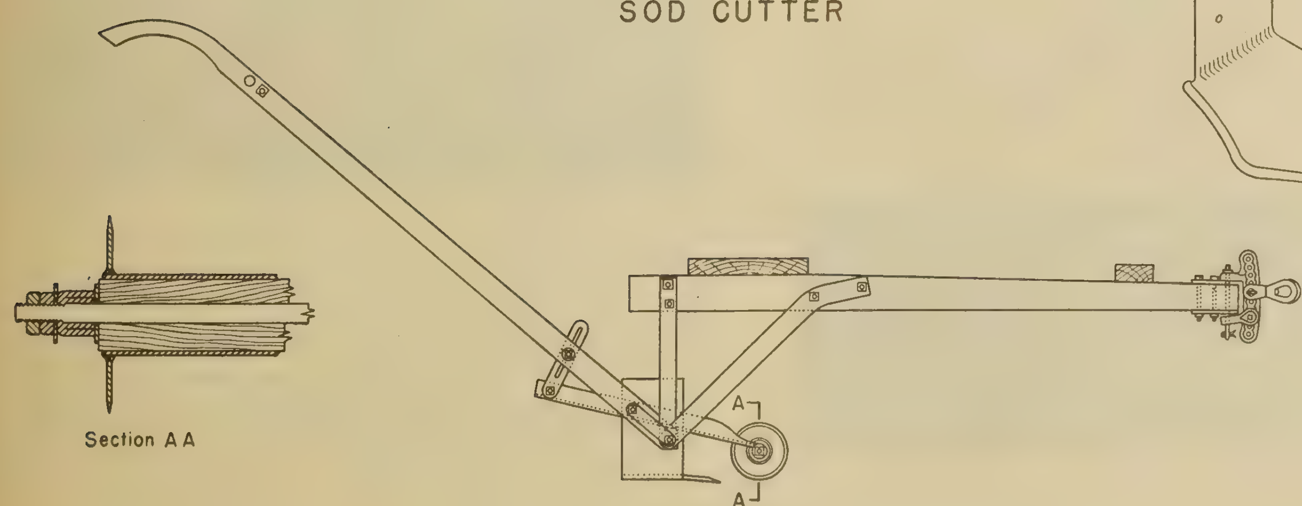
SIDE VIEW



BLADE DIAGRAM

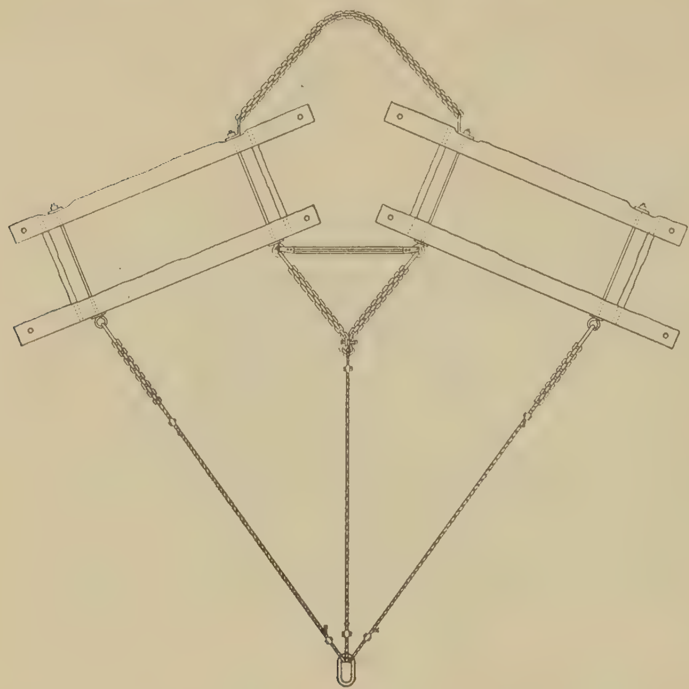
SOD CUTTER





Section A A

SPLIT LOG DRAG FOR TERRACING

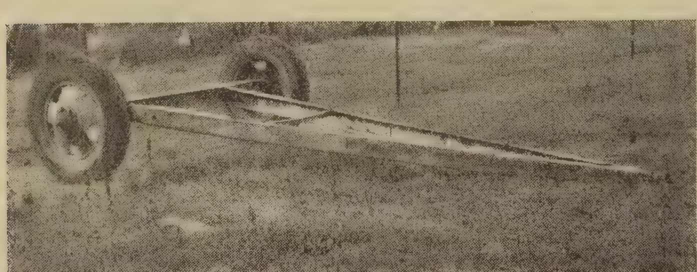


channel. Another advantage is that it is possible to cut all of the sod where that is desirable. Since with this machine the depth of cut is regulated by the roller rolling over the sod, it becomes unnecessary to leave a strip of sod outside the knife so that the runner on that side may have space to operate.

This cutter has been used very successfully in cutting bluegrass sod. Bluegrass sod takes root much more quickly if it is cut less than 2 inches thick, preferably not over 1½ inches. The sod, when cut thin, is rolled in convenient-sized rolls and handled in the same manner as that used by contractors when they sod a lawn. Usually the machine is pulled by a pick-up or a horse. Two boys using a horse can easily cut and roll up enough sod to keep several sodding crews busy.

Split-Log Terrace Drag

At the project at Minden, La., a split-log terrace drag has been constructed. This is used for smoothing up the terrace ridge after the ridge has been built to the proper size with the terracer. The diagram fully



explains the construction of this equipment. The dimensions as shown may be changed to fit any terrace section. The purpose of this drag is to smooth out the furrows in the newly built terrace ridge without the necessity of making several trips with the terracer. Both sides of the terrace are covered at a single trip.

Pile Driver and Trailer

Many of the camps, particularly those in Minnesota and Wisconsin, have constructed pile drivers. The accompanying picture is of one which was designed and constructed entirely by the personnel of the E. C. W. camp at Zumbrota, Minn. A second-hand

winch and old truck motor are used to furnish the power and raise the 1,435-pound hammer.

A trailer, the picture of which is shown, was also built by this camp and is used to move the pile driver as well as to perform many other duties. The pile driver is loaded and moved under its own power by detaching the cable from the hammer and hitching

when the sod is to be used in "solid sodding" a water it to the back of the trailer when loading, or to a tree or post when moving.

The camp at Red Wing, Minn., has constructed, in addition to the heavy-duty machine, a small hand-operated pile driver equipped with a 200-pound hammer. Because of the ease with which it may be transported and set up it is used for small jobs. This machine may be used on sheet piling and on round piling up to 14 feet long and 9 inches in diameter. A penetration of 8 feet is secured. A picture of it set up in operating position is shown.

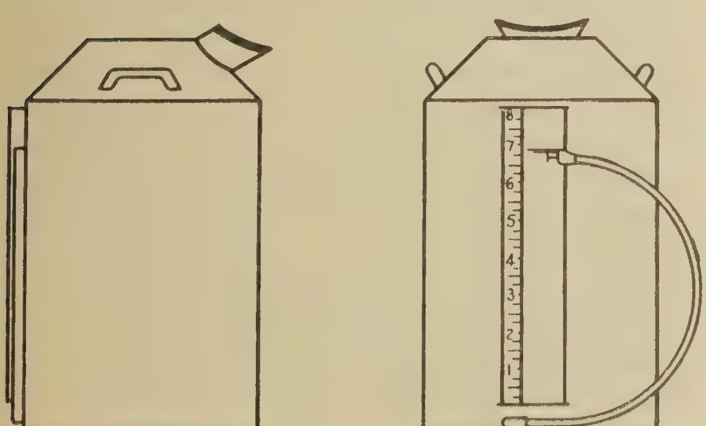
A sketch is shown of a cornfield roller devised by the LeRoy, Ill., project. This machine was developed for the purpose of mulching-in sweetclover seed, when sown in cornfields after the final cultivation.

Keeps Water-Cement Ratio Uniform

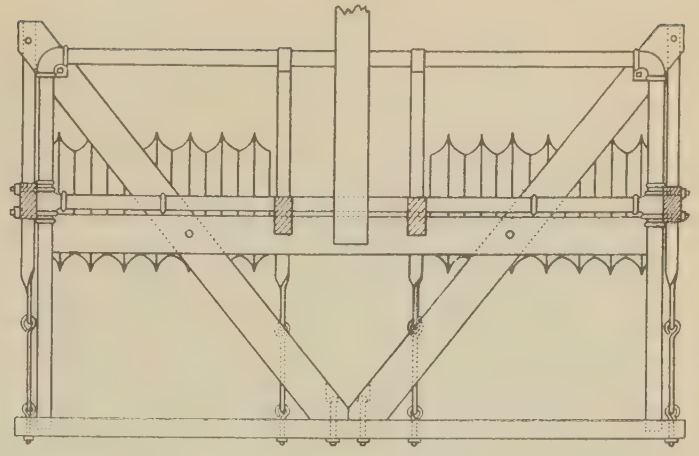
The E. C. W. camp at Galva, Ill., has constructed a water measuring can, used in concrete work, which makes it possible for the water-cement ratio of the mixture to be kept uniform. This measuring can, a sketch of which is shown, consists of a 10-gallon milk can with the top cut off just above the handles and a pouring spout soldered on. On the opposite side, a hole is drilled near the bottom of the can and a small elbow soldered in as shown. A scale showing the contents of the can in gallons and quarts is soldered to the can just above this elbow. Another elbow is attached to the scale in such a manner that it can be moved up and down. A pointer is soldered to this elbow flush with the top so that it points to the figures or scale. Then the two elbows are connected with a rubber tubing.

After the correct quantity of water to be added to any mixture has been determined, the pointer is set to the desired quantity and the can filled until the water runs out of the upper elbow, for each batch.

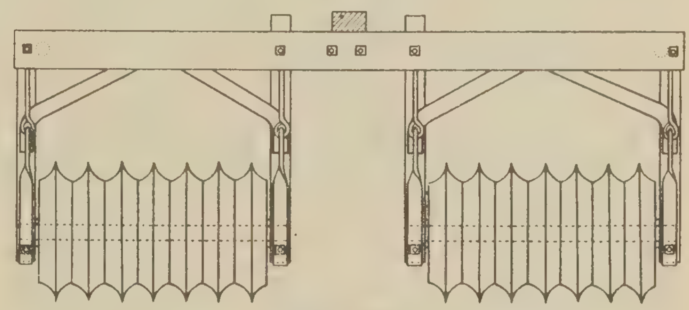
WATER MEASURING CAN



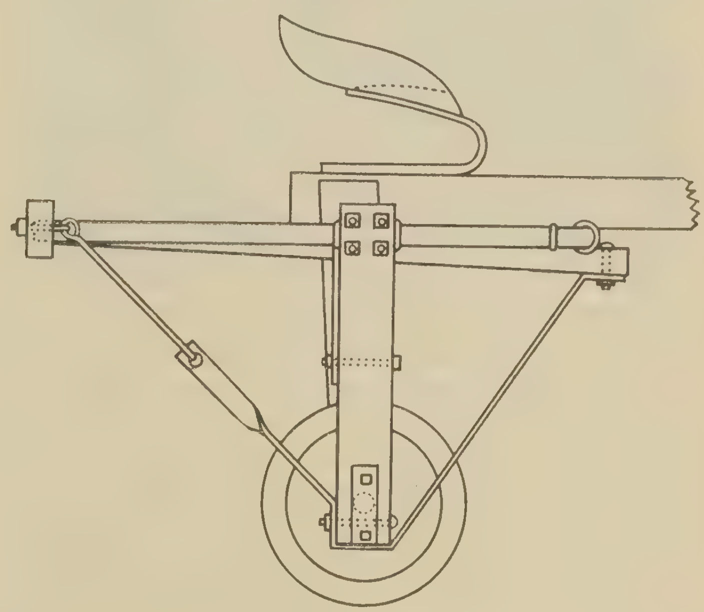
CORN FIELD ROLLER



TOP VIEW



REAR VIEW

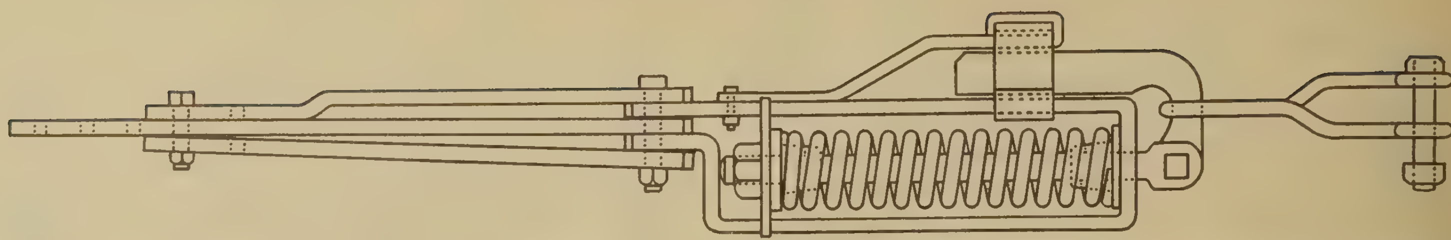


SIDE VIEW

Device to Protect Implements

A spring trip tractor hitch has been designed on the project at San Angelo, Tex. The purpose of this hitch is to protect implements which are pulled by a tractor from injury when roots or stones are struck. This hitch can easily be made in any project shop from the sketch shown. It will be necessary to purchase a spring having the proper compressive strength.

TRACTOR HITCH



It is probable that many other devices and tools have been developed in the various projects and camps. A description of these will be given in future articles as they are reported to this office.

Numerous changes and additions have been made to existing equipment to make it more adaptable to the job being done, some of which are given below.

For Harvesting Lespedeza Seed

A picture is shown of a seed-catching attachment for an ordinary mower. It is used in harvesting

lespedeza seed and was developed by a farmer living near York, S. C. A section of sheet metal is attached to the cutter bar and trails on the ground under the bags, thus preventing them from wearing through when dragged on the ground.

Another seed pan is reported from the project at Garland, Tex. It is constructed of sheet metal and is 31 inches long and 9 inches deep. It attaches to the back of the cutter bar. A drop end gate is held in place by two spring catches. The attachment works on the same principle as the lawnmower grass catcher.

In operating the mower and pan, one man follows behind the pan, keeping the seed and grass swept to the rear of the pan. A broom is used for this purpose. When the pan becomes full the attendant applies sufficient pressure to the end gate to cause it to open. The grass is then swept out in a pile without stopping the team.

Many of the camps and projects report placing centrifugal pumps on their concrete mixers to draw water from the source of supply and deliver it to the automatic measuring device on the mixers. These pumps are operated from the mixer motor.

Improved Pulverizers

The operation of pulverizers has brought about the development of many ingenious devices which improve the operation of these machines. The project at Caledonia, Minn., has mounted a barrel behind and above the feed opening. This barrel is filled with water and is connected to a pipe having a row of small holes in the lower side, which is placed at the back edge of the feed opening. A valve by which the flow of water can be regulated is placed in the connecting line. The project personnel claim that by properly regulating the flow of water, the amount of dust can be reduced below the nuisance point without reducing the production of the pulverizer.

From the project at Madisonville, Ky., comes the report that they have completely enclosed the lower as well as the upper elevator chain on their pulverizers. It is said that this prevents leakage of the pulverized lime and reduces dust materially. The project at Bedford, Ind., has constructed a sectional downspout for their pulverizer elevator consisting of sheet metal frustums linked together with chain. This downspout is similar to that used on silo fillers and may be lengthened or shortened by adding or removing sections.

Whisker Dams

(*Continued from p. 175*)

of the larger and steeper gullies, the cost of labor and materials is avoided. Expensive machinery is not required to build a whisker dam, and labor costs usually are such as may be supplied from the farm force. Considered in connection with other methods of controlling run-off, they promise even greater savings.

Rough tillage enables the soil to absorb the water more quickly. The practice of trashy summer-fallow likewise increases the water-holding capacity of the soil and, by means of "ten billion little dams", impedes the flow of water down the hills. Close-growing vegetation above the waterways will lessen the amount of water to be carried.

RECONNAISSANCE MAPPING OF NATURAL VEGETATION OF CENTRAL GREAT PLAINS REGION[1]

By Ben Osborn and H. L. Whitaker[2]

Typical scene in type phase of Quercus-Carya *(oak-hickory forest) in West Tuay Creek project, Ottawa, Kan. The shaggy-barked tree at right center is* Carya ovata K. Koch *(shagbark hickory), one of the dominants found only in old established stands of timber of this type.*

In the spring of 1936 the authors made a reconnaissance of the natural vegetation in the Central Great Plains region (Nebraska and most of Kansas and Oklahoma), and mapped on a scale of 1 inch to the mile the original native vegetation in the 15 demonstration areas there.

From 3 to 8 days were spent in each watershed area. Usually the first day in each area was used in taking floristic samples of the different types of vegetation and giving the area a general preliminary inspection. With a base map obtained from project headquarters. mapping was begun the second day.

The time required to complete a map depended upon the size of the area and the complexity of the vegetative pattern. In prairie country it was usually possible to see and to map the terrain for a mile in either direction from a car while driving at an average speed of 10 miles an hour. In wooded country it was more often necessary to drive along every section line. Aerial photographs helped considerably in locating boundaries of the forest types and phases.

These studies of the vegetation in the 15 projects scattered over the three States, and a limited amount of travel about the region, coupled with a study of the available literature on the flora and ecology of the Central Great Plains, enabled us to develop an ecological classification of natural vegetation of our region for reconnaissance use. We feel that the same methods could be used in other regions where sufficient relicts or records of the original vegetation remain to show the distribution of the dominants of the various communities.[3]

In this classification we have attempted to recognize the significant ecological units of vegetation within our region and to show their successional relationships in so far as can be determined from the present literature and reconnaissance field examinations.

The classification is necessarily provisional and, in order to be practical for reconnaissance use, is based upon empirical criteria which may be readily distinguished in the field.

The unit of an ecological classification of vegetation is the *association;* that is, the consistent occurrence together of certain species of plants in a recognizable

[1] This is the second of two articles. The authors wish to express their appreciation to Dr. Paul B. Sears and Dr. A. O. Weese, of the University of Oklahoma; Dr. F. C. Gates, of Kansas State College; Prof. H. I. Featherly, of the Oklahoma A. and M. College; and members of the technical staff of the Soil Conservation Service region 7, for their helpful suggestions and valuable criticisms in the development of the system of classification and method of mapping presented in this paper.

[2] Mr. Whitaker is regional biologist; Mr. Osborn is junior biologist, region 7 Soil Conservation Service.

[3] A more detailed exposition of our system of classification and of the ecological relationships, composition, and distribution of the various types of vegetation of our region is contained in our paper, "A Reconnaissance of the Natural Vegetation of the Central Great Plains Region", which is yet in manuscript form but which is available in the Soil Conservation Service regional office.

unit of vegetative cover under the influence of a single dominant or a few codominants. This is not to be confused with the formalized use of the word "association" by some recent ecologists as a designation of one of the major climax divisions of vegetation.

The delimiting of the associations in the sense herein employed usually requires more detailed study than is possible in a reconnaissance survey. The smallest division which we have found practical to recognize in reconnaissance mapping is what we have termed the *phase*, a successional series of associations of which each association is a *stage*. All the phases which lead, at least theoretically, to the same final association are considered to belong to the same type of vegetation. Those stages in which the characteristic species or genera of the final association are represented are said to belong to the *type phase* of that type of vegetation. Those stages or associations which develop in habitats more hydrophytic than that ordinarily occupied by the type phase are termed the hydrophase. Likewise, those which develop in habitats more xerophytic than the usual environment of the type phase are classified in the xerophase.

As names of these various divisions and subdivisions of vegetation we have attempted to use characteristic dominant or codominant species of the respective stages, phases, or types.

The types of vegetation are found related, primarily according to growth form, in *formations* coinciding with the accepted usage of this category in current ecological literature.

A further subdivision of the type into subtypes has been used to express the difference between the composition of the type in its different geographic portions.

This classification of vegetation has given us twelve types or ecotone types belonging to four different formations in our region. As a legend for our completed maps we have assigned a letter to designate each of these distinct types. The capital letter alone is used to signify the type in its entirety, including all its successional stages. If the type has been further classified as to subtype, an inferior numeral is used with the letter to designate the subtype to which it belongs. The capital letter with a prime (as A') designates the type phase of the type for which that letter stands. Small letters are used for the two successional phases, a small letter without a prime designating the hydrophase (a) and a small letter with a prime (a') designating the xerophase. Figure 1 illustrates the use of this legend upon a completed map.

By this method it is possible to use the same legend and be as specific or as general in the classification of

An example of a forest type of vegetation invading an original grassland community. A mixture of pioneer shrubs of the Quercus-Carya *(oak-hickory forest) type establishing themselves in a watercourse running through an* Andropogon *(tallgrass prairie) type meadow. Grasses may be seen in the foreground. This woody community would not appear on the map of "original" vegetation.*

the different units of vegetation under consideration as the circumstances demand. In reconnaissance work, it sometimes is impossible to determine reliably the particular phase or subtype of vegetation which originally occupied an area when the type may be determined with certainty. In that event, the legend for shiftings in boundaries and the complication of the pattern by secondary successions. Each area presents a problem of its own which can be interpreted only in the light of a knowledge of its agricultural history (or history of disturbance) and of the important secondary successions.

To the casual eye this is tallgrass prairie, but the ecologist will observe the relicts of Quercus marilandica *Muench (blackjack oak sprouts) visible in the upper portion of the view and will map it as originally occupied by the* Quercus marilandica Andropogon *ecotone type.*

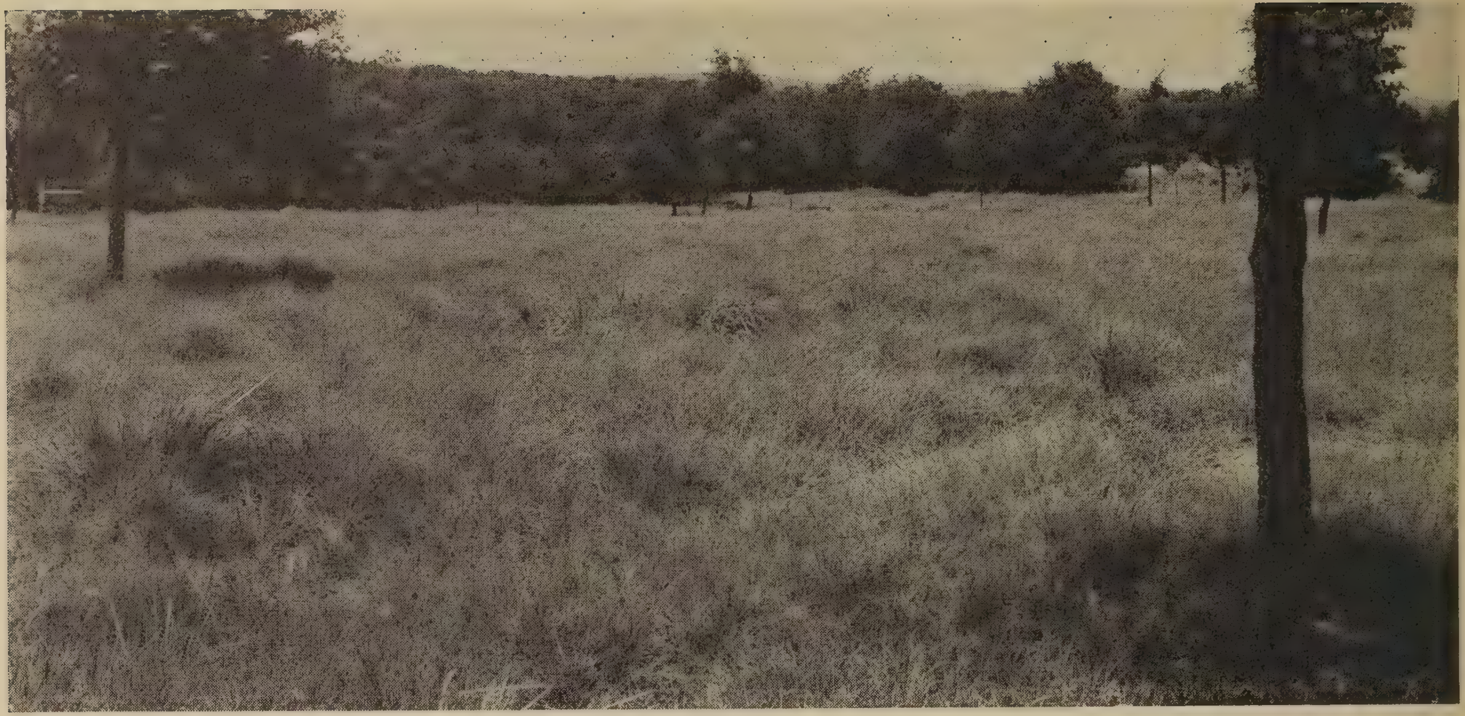
the generalized type may be used. Sometimes it may be possible to carry the classification no further than the formation, in which instance a roman numeral may be used in the legend. Divisions of different categories may be expressed on the same map, portions of the area being classified to their exact phases or subphases while more difficult parts are recorded only by the formations to which they belong.

A familiarity with the dominant species of the various stages within the several phases and types of vegetation is necessary to the recognition of these units in the field as the boundaries of the different communities are delineated upon the distribution of these dominants.

Needless to say, in mapping the original vegetation after several years or even decades of disturbance by agriculture, it is necessary to consider the possible

A preliminary trip over the area and a floristic sampling of the apparent different types of vegetation will generally serve as a basis for interpreting relict evidence of the original boundaries of the various plant communities. Usually it is possible after such a preliminary examination to draw the original boundaries directly upon the base map. If there has been much disturbance, however, it may be necessary to plot upon the map the locations of relicts of the origina vegetation. From the completed map of relict local tions the boundaries of the original communities usually can be deduced.

The known preferences of certain communities for certain types of habitat will aid in assigning original boundaries, but should be used as secondary rather than as primary evidence. It is important to remember that *the vegetation is the indicator of the environment,*



Quercus marilandica-Andropogon (*blackjack-oak Savannah) ecotone type at the Red Plains Soil Erosion Experiment Station, Guthrie, Okla. Note the tall grasses in the opening in the blackjacks, also the isolated trees in the grass stand, indicating the natural mixture of the two types of vegetation. At one time this was a badly overgrazed pasture, but protection from grazing and burning has permitted reestablishment of tallgrass species.*

This relict stand of Andropogon scoparius *Michx. (little bluestem) among the rocks where it is partially protected from grazing in a pasture in Saline county, Kan., is typical of the evidence that this prairie country was originally occupied by* Andropogon *(tallgrass prairie) type of vegetation.*

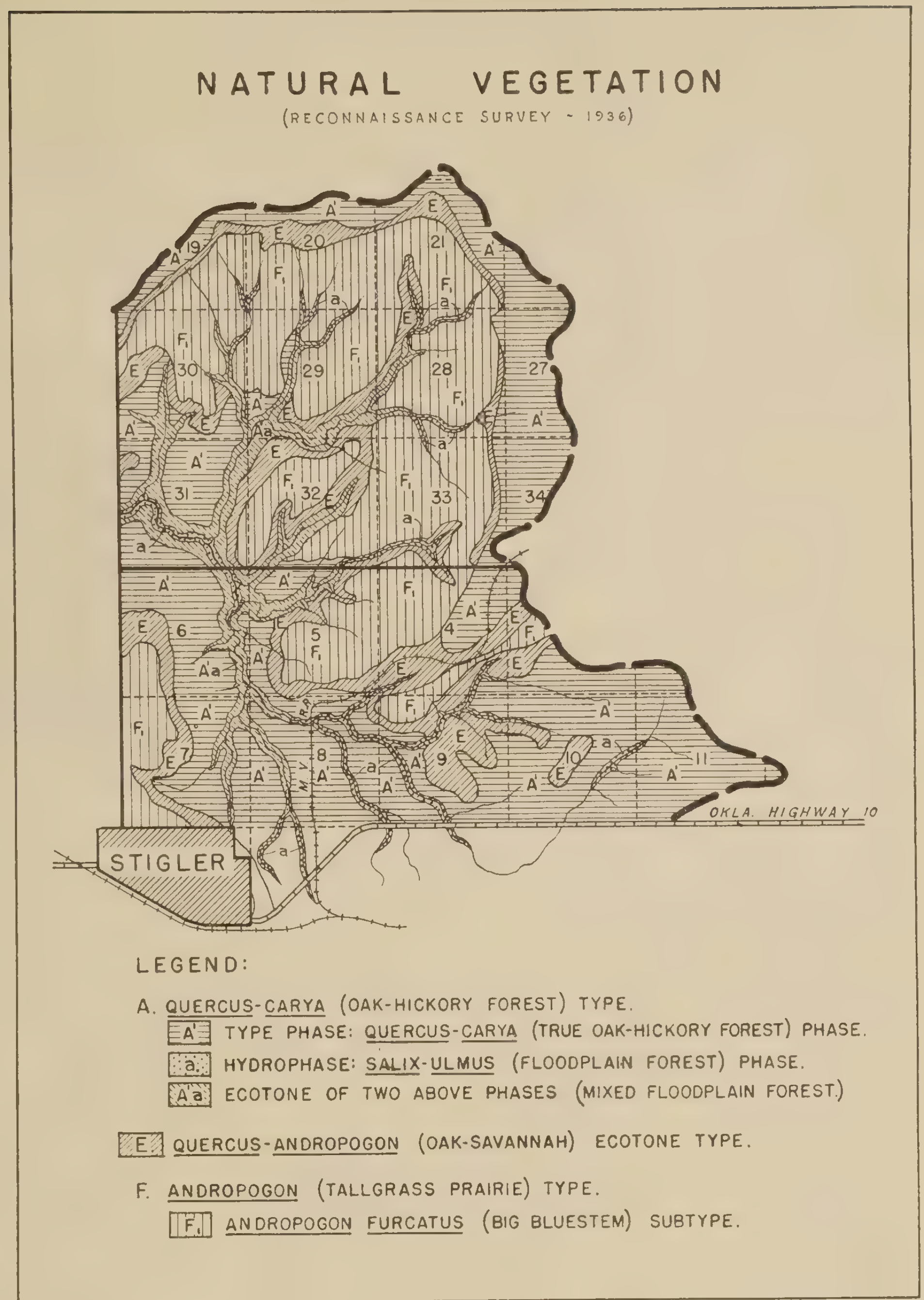
not the environment the indicator of the vegetation. Human appraisal of a given habitat may not necessarily be the same as that of the plant community faced with the problem of survival in that habitat.

If aerial photographs of the area are available, often it is possible to map the vegetation from them, after a preliminary field examination to determine what types and phases are present and the usual arrangement.

Earlier Phases Deceiving

Particular attention should be called to the deceptiveness of the early successional phases of the forest types of vegetation where they make contact with grassland types. In areas where disturbance has been present for a good many years, secondary successional tree communities may be growing upon areas which were not originally occupied by forests. Examination of tree rings and other evidence of the age of the community and a careful search for relicts of possible original grassland types are necessary to determine the status of present vegetation on the ground.

Attention should be called also to the general shift of types within the grassland formation to the eastward or to different portions of the topography in response to the varying effects of different degrees of overgrazing, erosion, and drouth. Here again relicts are of paramount significance. In the Central Great Plains Region an area generally can be assigned to the most nearly hydrophytic type of which relicts are present.



A portion of the reconnaissance survey map of the original natural vegetation of the Taloka Creek area, Stigler, Okla. Sections are bounded by broken lines. Different types of hatching have been substituted for the colors used in the original map.

Two Types of Relicts

In this connection two types of relicts should be recognized. The more significant and reliable is a patch of sod or area of timber which has never been broken or cleared and in which the original plant community, and possibly some of the identical individuals of the original stand, remain. This may be called a *community relict* and is reliable evidence of the original occupation of that area by that type. The second type of relict, which may be called a *species relict*, consists of the presence of a species from the original community, but not necessarily in its original position. It simply indicates the persistence of that species within the area. This type of relict will be significant in indicating that the environment permits of the survival of the species, which may be taken as an evidence that the community from which it is derived may originally have occupied the territory.

How the dominant species serve to classify different units of vegetation may be seen in the accompanying chart of dominants of the types and phases found in

the map shown on page 135. A corresponding chart compiled for the types represented in any region under consideration would serve as a guide to identifying those types in the field in that region.

Dominant species determining the types and phases of natural vegetation mapped in the Taloka Creek Area are shown in the following tables.

The table does not include all of the units of vegetation encountered in Region 7, but only those occurring in the area shown in the accompanying map

I. *Quercus-Fagus* (DECIDUOUS FOREST) Formation

Trees (or shrub species of the xerophase) in the absence of dominant grass species:

Dominant species	Phase or subtype	Type
Quercus spp. (Oak.) *Carya* spp. except *C. pecan.* (All Hickories except Pecan.)	A′ Type phase: *Quercus-Carya* (True Oak-Hickory Forest) Phase.	
Salix spp. (Willow) *Populus* sp. (Cottonwood) *Celtis* spp. (Hackberry) *Ulmus americana* L. (American Elm) *Ulmus fulva* Michx. (Slippery Elm) *Carya pecan* Engl. & Graebn. (Pecan) *Platanus occidentalis* L. (Western Sycamore) *Betula nigra* L. (River Birch)	*a.* Hydrophase: *Salix-Ulmus* (Floodplain Forest) Phase.	A. *Quercus-Carya* (Oak-Hickory Forest) Type.
Dominants of the type phase (A′) occurring with dominants of the hydrophase (*a*).	A′*a*. Ecotone of type phase and hydrophase (Mixed Floodplain Forest).	
Rhus glabra L. (Smooth Sumach) *Rhus copallina* L. (Shining Sumach) *Symphoricarpos orbiculatus* Moench. (Common Buckbrush) *Diospyros virginiana* L. (Common Persimmon) With associated shrubs and vines in the absence of dominant tree or grass species.	*a*′. Xerophase: *Rhus-Symphoricarpos* (Shrub) Phase.	A. *Quercus-Carya* (Oak-Hickory Forest) Type.

II. Forest-Grassland Ecotones (SAVANNAHS)

Tree or shrub dominants from the *Quercus-Fagus* (Deciduous Forest) Formation with an intergrowth of grass dominants from the *Andropogon-Bouteloua* (Grassland) Formation, either as a uniform mixture or in relatively pure patches too small to be mapped separately:

Dominant species	Phase or subtype	Type
Dominant species of the type phase of the *Quercus-Carya* Type (A′) with dominant species of the *Andropogon* Type (F).		E. *Quercus-Andropogon* (Oak Savannah) Ecotone Type.

III. *Andropogon-Bouteloua* (GRASSLAND) Formation

Grasses in the absence of significant tree or shrub dominants:

Dominant species	Phase or subtype	Type
Andropogon spp. (Bluestem.) *Sorghastrum nutans* (L.) Nash. (Nodding Indiangrass)	F′. Type Phase: *Andropogon* (True Tall-grass Prairie) Phase.	
Andropogon furcatus Muhl. (Big Bluestem) Other species subordinate to this dominant.	F. *Andropogon furcatus* (Big Bluestem) Subtype.	F. *Andropogon* (Tall grass Prairie) Type.
Panicum virgatum L. (Switch Panic-grass) *Spartina pectinata* Link. (Prairie Cordgrass)	f. Hydrophase: *Spartina-Panicum* (Wet Meadow) Phase.	

Strip cropping in Ohio: The photograph that suggested this month's cover.

ONE ANGLE OF THE FLOOD PROBLEM

Rivers out of their banks caused little or no loss to the Indian inhabitants of pre-colonial days. The white colonists who came over the Alleghenies, however, traveled farther inland by boat and established their settlements close to the banks of their river highways. From the first they felt the wrath of rising waters. When great cities grew up and industrial districts, railroad yards, and warehouses were forced into the low-lying regions, even floods of no greater magnitude than those of prehistoric times could take a rising toll of lives and dollars.

But the things that modern civilization—man-made geography—has done to the face of the earth have raised flood levels year after year. Streams that formerly utilized their age-old safety valves by spreading over worthless low lands have been confined by embankments and levees. Forests have been cut down; ground has been covered with the sloping roofs of buildings; streets and roads have been made impervious to water by paving; drainage ditches have been dug; hillsides have been plowed carelessly. Every falling drop of water in great areas has been helped to flow more quickly into streams—streams that have themselves been narrowed. Each decade, therefore, has seen old flood levels passed, even when rainfall has not increased. [Adapted from bulletin issued from headquarters of National Geographic Society.]

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

SOIL DEFENSE IN THE PIEDMONT. By. E. M. Rowalt. In Collaboration with Subject-Matter Specialists of the Soil Conservation Service. U. S. D. A. Farmers' Bulletin 1767. January 1937.

Within late years it has been established as a fact that unless measures are taken to restore eroded and gullied lands of the Piedmont and to prevent further soil waste, the agricultural security of the region will rapidly become a thing of the past. This bulletin not only presents a comprehensive brief history of the area in explanation of conditions as they exist, but explains fully the modern approved methods now being used for soil defense in this rolling foothill country extending through Virginia, the Carolinas and Georgia, and into Alabama. Mr. Rowalt's writing guides the reader, smoothly and surely, in "thinking" himself into the region and its soil problems.

In the early days of its settlement by white men the Piedmont was a land of luxuriant valley bottoms and forest-covered slopes, with loamy, humus-filled, granular soils through which surface waters slowly filtered to clear streams. The soils of sandy loam lay over the region as they had been formed throughout the ages and were held in place by roots of plants and protected and made absorbent by a layer of decaying vegetable matter. Water-power resources were such that every settler could have a mill of his own for the grinding of his grain. Forest-covered slopes protected the lowlands from destructive floods.

Today farming in the Piedmont is a precarious venture. For the reason that they were infrequent and scattered, and mechanical structures crude and ineffective, attempts by individual farmers throughout the past century to save the soil were failures. Gullies formed at terrace ends and from hillside ditches. Topsoils washed from deforested slopes into the streams; bottom lands became buried in unproductive silt. Sheet erosion appeared on field after field. There are areas in the Piedmont which lost all their topsoil by sheet erosion within the short space of 30 years.

When figures were assembled from the reconnaissance survey made in 1933–34 by the Soil Conservation Service, the Piedmont as it emerged from a century and more of harmful agricultural practices was revealed as one of the most seriously eroded regions in the United States. With a large percentage of the area deprived of three-fourths of all its topsoil, it became apparent that the good land which remains must for the security of the population be protected from further impoverishment through erosion.

In recent years, with the realization that, given the opportunity, nature will work with man instead of against him in a constructive program for soil husbandry, erosion-control measures have taken a new course. The body of this bulletin describes separately and in detail the important practices now used in defense of Piedmont soils. Photographs are included to clarify explanations.

The modern broad-base terrace, as based on the principle that "slowing the speed of flow of water causes it to lose most of its power to carry a soil load", is described with regard to design and effect. The Nichols terrace, preferred for Soil Conservation Service demonstration areas in the Piedmont, is referred to as "an intercepting and drainage structure" and when constructed and maintained with care as to proper grade in the channel, takes advantage of water flow by breaking a long steep slope into a series of modernate slopes. As expressed by the author, "the Nichols terrace is, essentially, a broad, shallow ditch buttressed on the lower side by an embankment of earth. It is built entirely from the upper side by moving the soil down from above. Most of the water behind the terrace flows in a channel below the original surface of the ground, and complete terrace failures therefore seldom occur."

A table is included showing recommended spacing with regard to slope gradient for terrace construction. The laying out and maintenance of waterways for prevention of gullying is discussed in detail as the important feature of successful terracing.

As to contour tillage, a second soil-saving measure, Mr. Rowalt emphasizes its importance by stating that "row crops on all sloping lands in the Piedmont should be grown on the contour" for the saving of labor, water, and soil. Contour furrowing should be practiced particularly on upper terraces, with the terrace as the contour line—this measure being of value in slowing flow of water on upper intervals where erosion is most severe. In connection with contouring, strip crops are recommended to protect erodible slopes in times of heavy rains. Small grains, sorghums, clovers, grass, vetch, and lespedeza are mentioned in particular for strip cropping in the area under discussion. Lespedeza, and mixtures of sorghum and soybeans and cowpeas, are of especial value both as soil savers and forage crops. Rotating strips is stressed for double protection.

The fact is pointed out that cotton, corn, and tobacco, grown persistently throughout many decades in the Piedmont, are largely responsible for the serious soil waste in the region. Results of tests are given to show that legumes, small grains, and pasture grasses, used in proper rotation, will decrease soil losses, conserve moisture, and at the same time add organic matter. Of all the plants tested, lespedeza and Bermuda grass proved most efficacious for protection of the eroded slopes and buried bottom lands.

Another measure, recently adopted, which has proved extremely practical in sections of the Piedmont is contour furrowing in pastures. This is for the conservation of moisture and, indirectly, the control of erosion on slope pastures. Before the furrowing is done, all eroded spots and small gullies should be plowed, smoothed, fertilized and limed, and seeded.

An important feature of this bulletin is the section dealing with gully control. Emphasis is placed on the use of grass dams for the quickest method of securing a stabilized soil condition in gullies in cultivated fields. Such a gully may, in some instances, be partially filled by plowing, then seeded to grass mixtures or perennial legumes and grasses, thus converting the gully into a grass waterway. Temporary dams or diversion ditches are frequently necessary to divert the water until revegetation is secured—this in the large gullies. Many plants native or adapted to the Piedmont have proved themselves of inestimable value for gully control. The perennial legumes, kudzu, and *Lespedeza sericea;* the black locust tree and native pines; honeysuckle; and grass mixtures have proved most successful.

In a chapter with the heading "Etching the Story on the Land" Mr. Rowalt describes the erosion-control demonstration work in five Piedmont areas, i. e., the Banister River of Virginia, Deep River in North Carolina, South Tiger River in South Carolina, Sandy Creek in Georgia, and the Buck and Sandy Creek demonstration of Alabama.

A final chapter tells how terracing clubs in Tallapoosa County Ala., grew into soil-conservation associations with full programs involving * * * "the building of terrace-outlet channels, abundant use of cover crops in an improved crop rotation, contour-tillage, strip cropping, gully control, permanent-pasture seedings, forest plantings, and practices for wildlife conservation."

SOIL CONSERVATION SURVEY OF THE SOUTHERN GREAT PLAINS WIND-EROSION AREA. By Arthur H. Joel. U. S. D. A. Technical Bulletin No. 556. January 1937.

This analysis of the erosion conditions in a 25,000-square-mile area in the heart of the so-called "dust bowl" is not merely a survey report. In addition to the presentation of data gathered by the Soil Conservation Service reconnaissance survey the author gives a comprehensive discussion and interpretation of the various conditions identified and mapped, particularly with respect to wind erosion and associated problems. Mr. Joel is in charge of the western field office, Section of Conservation Surveys, Soil Conservation Service.

The area includes 20 counties in southeastern Colorado, southwestern Kansas, and the Texas and Oklahoma Panhandles. With its limited precipitation, high average wind velocity, generally thin stand of short grass and associated plants, and its unconsolidated soils of various stages of development, this region becomes peculiarly susceptible to accelerated erosion by wind over the whole 20 counties and by water in limited sections of unproductive soils. During recent years, with intensive grazing and cropping and failure on the part of landowners to provide adequate protection for the soil, the situation has reached the point where it requires serious attention founded upon a full knowledge of facts as they exist.

The survey involved the collection of data regarding climatic conditions of the area, general topography, vegetation, soils as related to erosion, agriculture and land use, and types and degrees of accelerated erosion.

In the study of the soils from the standpoint of erodibility, nine groups were used, each having types with distinctive and related features and characteristics of erosion susceptibility and erosion-control possibilities. It was found that soils of group 1, comprising 24.5 percent of the surveyed area, consist of silt loams and clay loams and are underlain by heavy clay subsoils. The topsoils when cultivated become loose and friable and are high in moisture-holding capacity, although their absorptive capacity is relatively slow. Owing to their loose friable structure they are very subject to wind erosion. The lands are heavy and generally of smooth topography and therefore suited to wheat production with the use of heavy farm machinery. When not properly cultivated, however, young plants often suffer from wind erosion.

Soils of groups 4 and 5, comprising a little more than 35 percent of the area, include the heavier and light sandy soils, and are readily susceptible to serious wind-erosion damage under cultivation, unless the farming system is well adapted to moisture conservation and erosion control. Large areas of subsoil are already exposed on these types, and sand dunes have formed in some localities. The author states that these sandy soils usually are well adapted to crops of the sorghum family and that these fibrous-rooted plants are especially useful on areas where the wind erosion is serious. Soil groups 6, 7, and 8, totaling 5.7 percent of the area surveyed, include the dunes, stationary and shifting, and the stream bottoms and terrace-lands used mostly for pasture or seriously eroded. The land of group 9 is chiefly of rough, broken topography, much of it nonarable.

In the presentation of a table showing distribution of cultivated, idle, and pasture lands in the 20 counties surveyed, 1,380,414 acres are listed as idle land. Since this immense acreage has become temporarily or permanently abandoned largely because of serious wind-erosion damage, it is apparent that the necessity for control, to prevent increasing abandonment, is extremely important.

The erosion-conditions survey of the area is presented in detail and discussed at length. The field survey pattern is indicated on maps, thus furnishing a very helpful guide for the formulating of land-use readjustment policies. It is found from studying the data that 96.9 percent of the area is affected by accelerated erosion of various types and degrees, while 53.4 percent has been seriously affected. It is stated by the author that "wind erosion is not only by far the most important type of erosion, but also probably the greatest single physical problem facing the area."

Only 4.4 percent of the region is affected by water erosion; but since there is great loss of moisture on soils both cultivated and uncultivated, the need for moisture conservation is urgent. All soils except those of alluvial stream flood plains and low terrace lands (3.1 percent of the entire area) have been damaged to a serious degree and are therefore rated as seriously susceptible to erosion when unprotected by vegetation.

Remedial measures as set forth for the area, based chiefly on physical conditions mapped by the survey, include soil-conservation practices such as immediate revegetation, tillage in relation to erosion control, and moisture conservation, all to be based on basic surveys of lands affected. Land-use readjustments in relation to soils and erosion are recommended also. It is important that over-cultivated and idle lands be returned to permanent vegetation, that acreage be properly distributed, and that farming methods be adapted to the soil, climatic, and topographic conditions.

Accompanying the report, in the detached appendix, are individual maps of each of the 20 counties and a summary map of the entire area surveyed.

Eighteen Farmers say "We'll Do It Ourselves"

(Continued from p. 166)

Summary—H. W. Lawson farm

Crops	Average acreage before agreement	Acres of crops as planned in agreement 1937	1938	1939	1940	1941	Average acreage after agreement
CULTIVATED							
Corn	8	6	6	9	6	9	7
Tobacco	4	4	4	4	4	4	4
Cotton	...	...	...	...	...	...	...
Other row crops	...	3	3	3	3	3	3
Total	12	13	13	16	13	16	14
SEMIEROSION RESISTING							
Small grain	12	6	10	10	9	10	9
Beans and peas	...	...	...	...	...	...	...
Total	12	6	10	10	9	10	9
EROSION RESISTING							
Temporary meadow	...	13	9	6	10	6	
Permanent meadow	...	9	9	9	9	9	9
Total	...	22	18	15	19	15	18
Permanent pasture	...	14	14	14	14	14	14
Forest	...	75	75	75	75	75	75
Total	...	130	130	130	130	130	130

Treatment in effect before contract, 75 acres; treatment newly planned, 52 acres; erosion-control planned, 3 acres; retired from semierosion crops, 9 acres. Work stock, 2; milk cows, 3; hogs, 2; poultry, 50. Graindrill, 1; mower, 1; harrow, 1.

U. S. GOVERNMENT PRINTING OFFICE: 1937

Planning Boards Report on Soil Conservation and Related Subjects

Compiled by Mrs. Etta G. Rogers, Publications Unit

Field offices should submit requests on form SCS–37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

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Agricultural Exports in Relation to Land Policy. Part II of the Supplementary Report of the Land Planning Committee to the National Resources Board. 1935. 30¢ Paper Cover.

Agricultural Land Requirements and Resources. Part III of the Supplementary Report of the Land Planning Committee to the National Resources Board. 1935. 60¢.

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Indian Land Tenure, Economic Status, and Population Trends. Part X of the Supplementary Report of the Land Planning Committee to the National Resources Board. 1935. 20c Paper Cover.

[1] Not available for general distribution.

TWO HUNDRED YEARS IN THE PIEDMONT

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

MARCH

Featuring Articles Pertaining to Flood and Drought

1937

CONTENTS

THE COVER

Basin listing slows run-off and stores moisture against time of drought. It is a soil-conservation measure which allows slight deviations from the contour. The cover design was made from a photograph taken at Hays, Kans., following a heavy rainfall. The water is nicely pocketed upon the field.

SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. SOIL CONSERVATION seeks to supply to workers and cooperators of the Department of Agriculture engaged in soil conservation activities, information of especial help to them in the performance of their duties, and is issued to them free by law. Others may obtain copies from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic. Postage stamps will not be accepted in payment.

WELLINGTON BRINK — EDITOR

SOIL CONSERVATION

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Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

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ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

From Farm Fields to City Streets

by Carl B. Brown

CLEAN-UP week in the Ohio Valley follows the 1937 flood catastrophe. Hundreds of W. P. A. crews are at work resurrecting streets, water mains, and sewer lines from a choking blanket of mud. Refugees are trickling back into flood-stricken cities to survey in bewilderment the havoc in their homes. Two weeks have passed since the greatest flood of record swept down the Ohio Valley. The extent

NOTE.—The author is associate geologist, Section of Sedimentation Studies, Division of Research, Washington, D. C.

of recovery already effected is astonishing—a tribute to the capacity of the American people to snap back from major disasters such as seldom strike twice in one century. By February 13, Louisville, Ky.—hardest hit of the major cities—has its main business section plastered with signs reading "Open for business", "Open—with heat", or "Business as usual."

Mud Left in the Cities

Nevertheless, telltale evidences remain, even in the best of places, to show what efforts the clean-up required. For instance, I sat in the coffee shop of a first-class hotel in the heart of Louisville, reopened only 2 days before, and saw in nooks and crevices a dried scum of mud that soap and water couldn't reach. Only paint can remove those blemishes. Two feet of water had stood on the floor of that coffee shop. Never before had the coffee shop been within a mile of the river.

The condition in which homes were left by receding flood waters is almost unbelievable until you've seen it. This flood was no respecter of property rights. Mansions of the well-to-do suffered in common with negro shanties. The flood was bad enough at the time, but what it left was even worse. Had the flood been only water the outlook might not be so gloomy. Rugs, for instance, and curtains dry fairly well in the sun. But suppose you found, as these flood victims have, an inch or two of fine sticky mud clinging to your floors, a plaster of mud on your wallpaper, in your bureau drawers, mud even inside your mattress? Imagine your grand piano with a film of mud on every moving part. I saw several in this condition, and dozens of automobiles being disassembled completely for cleaning. Wherever the yellow swirling flood water found its way, you may be sure that mud was left to tell the story.

Other Side of Story

The other side of this flood aftermath is not in the flood zone at all. Any casual observer may see it, as I did, in driving through the Miami Valley above Cincinnati and from that city to Louisville. Hundreds of thousands of incipient gullies have developed during the phenomenal 12 days of rain that started the mad flood waters on their way. Fields on end—literally—hundreds of fields plowed straight up and down the slopes showed miniature canyons, up to 4 inches deep, in every furrow. Occasional new gullies, somewhat larger, cut diagonally across the rows. Altogether these countless thousands of new erosion scars must represent soil losses of millions of tons in the 12 days of rain. Of particular significance too is the fact observed during a drive from Dayton through Cincinnati to Louisville that not a single field showed soil-conserving practices which were unmistakably recognizable as such. Certainly there was no terracing and scarcely any contour plowing. True, much of the land is now in grass. How closely it is grazed is demonstrated by a flock of more than 3 dozen sheep that I saw grazing on a 3-acre hillslope off 1-inch grass. And this area from Dayton to Louisville is in the heart of the Ohio Valley.

At the bottom of several slopes on which the rows ran straight uphill, I examined silt that appeared to duplicate that collected on Cincinnati streets. The small fan-shaped patches of silt left behind at the bottom of slopes could be only a small part of that eroded from the fields above. The rest was a contribution to the Ohio flood waters. Various fractions of it have been dropped by flood waters between those fields and the Gulf.

Surveys Being Made

The Service is undertaking a reconnaissance survey of the Ohio Valley to determine the amount of sediment laid down by flood waters both in urban areas and on the river flood plain. Work on the urban areas was begun as soon as receding flood waters made the cities accessible. A field party of the Section of Sedimentation Studies, Division of Research, is making measurements and collecting samples of sediment in the 10 largest cities or metropolitan districts between Pittsburgh and Cairo. Reconnaissance surveys of the flood plain areas will be started by a field party of the Section of Conservation Surveys, Division of Operations, as soon as the bottom lands are drained sufficiently to permit access.

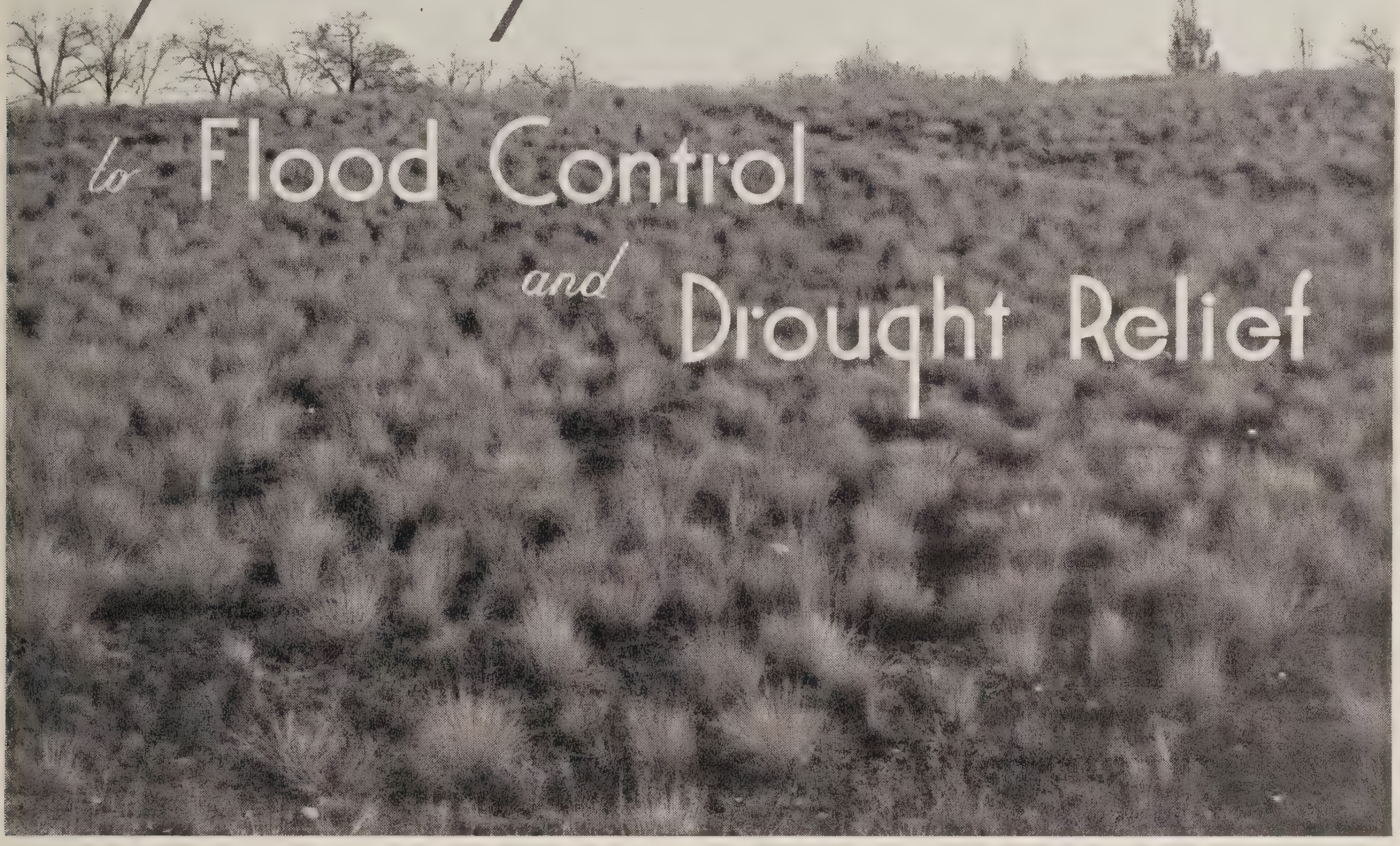
In the cities, thickness measurements of the sediment—mostly very fine silt, but occasionally very fine sand—are being so spaced as to give a basis for computing representative averages for various sections and then totals for the cities as a whole. A record is made of the apparent degree of dryness of sediment at each point of measurement. Numerous samples are being collected and sealed in glass bottles for moisture determinations. From these the dry weight and volume of sediment will be calculated. Measurements are being proportioned roughly between streets, yards, and building interiors.

Estimates Given

At the time this is written (Feb. 14), the reconnaissance of cities is about half completed. No computa-

(*Continued on p. 198*)

Agronomy's Contribution to Flood Control and Drought Relief



By C. R. Enlow [1]

FARMERS will generally tell you that a soil recently broken from sod shows very little sign of erosion. Experiments at soil conservation stations indicate that soils naturally high in organic content, or to which organic matter has been added, allow three to four times the infiltration of moisture that is allowed by the same soils depleted of organic matter and badly eroded. Severe wind erosion in the Great Plains did not take place until the organic matter in the soil had been greatly reduced by tillage and cropping.

When we first started to farm in this country, which was only a short time ago as compared with the length of the period covered by the world's agriculture, our soils were very high in organic matter. We felt, apparently, that the organic content of the soil was inexhaustible, judging by the farming practices that we followed and are still following to a large extent. These practices will be continued until it is generally realized that something must be done to maintain and improve the soil. Production of crops, tillage methods, erosion, leaching, and other factors caused by man's disturbance of the soil lower its fertility and organic content.

Organic Matter Must Be Restored

A program to conserve soil and water in cultivated fields and on pastures is principally one of maintaining or improving the organic content and fertility. Our fields were originally laid out without thought of preventing erosion. The practice of tillage across the slope was due at the beginning to the difficulty of pulling machinery up and down. Very little, if any, conscious attention was given to maintaining cover on the land throughout the year to prevent the soil washing away. Very little effort was devoted to the return of organic material lost through years of cultivation. No thought, apparently, was given to the necessity of maintaining the fertility of pasture lands in humid sections or to conserving the moisture

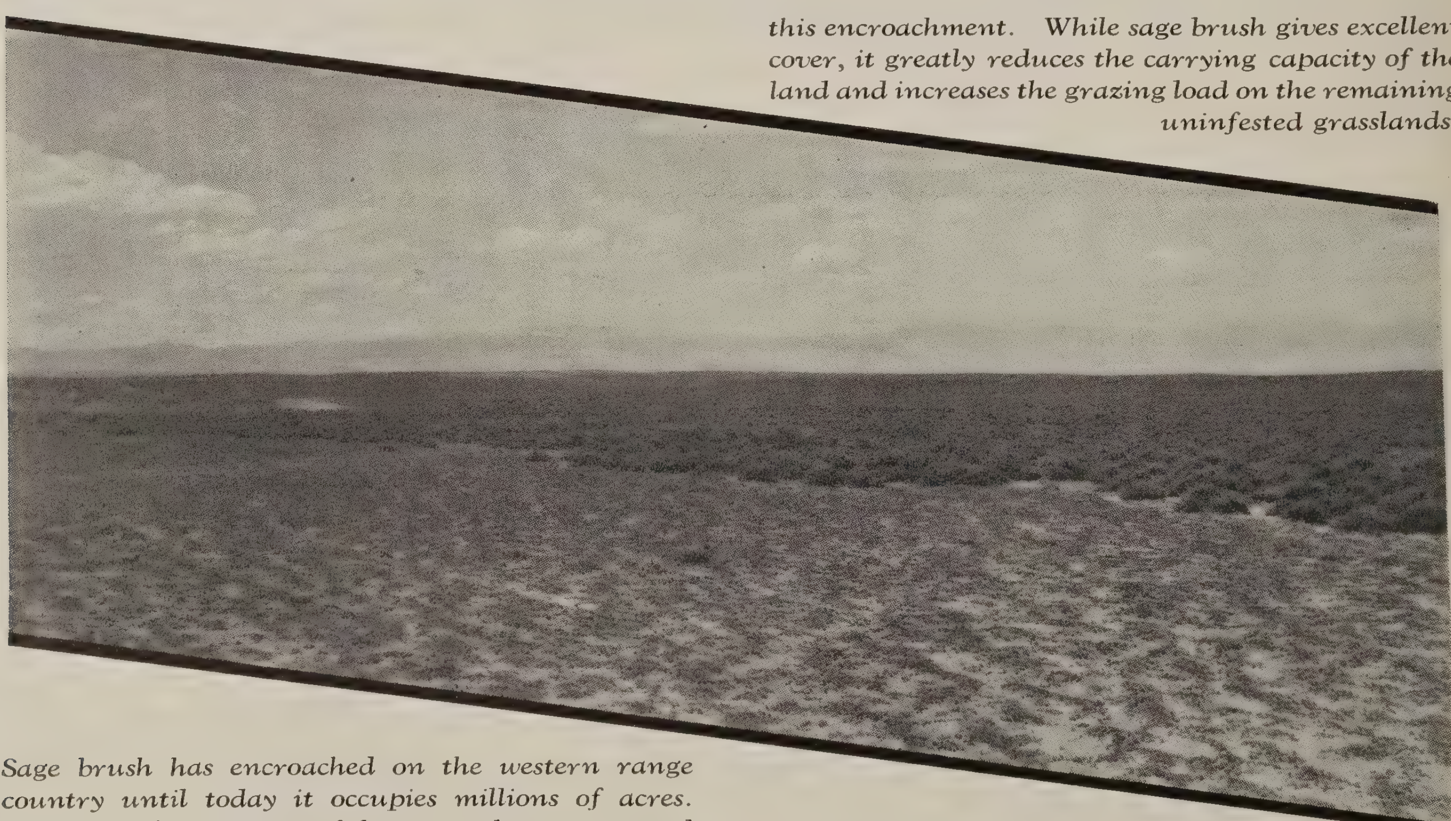
[1] Head, Agronomy Section, Soil Conservation Service, Washington, D.C.

Contour ridges in pastures have been used extensively in Texas. This picture was taken immediately after a 3-day rain totaling 18 inches, and the ridges were not damaged. Contour ridges on slopes greater than 5 percent have not proved effective in spreading the water over the area between ridges, to allow absorption. On slopes up to 2 percent they were completely effective in holding and distributing rainfall. Efficiency decreases as the degree of slope increases.

in semiarid pasture or range lands. Our grazing lands were regarded as a permanent source of income and only in the past few years have farmers in general recognized that formerly good pastures are now weed patches, badly eroded, and neglected.

The agronomists and range men of the Service can aid materially in minimizing flood hazards by encouraging a program to maintain good vegetative cover throughout the year, insofar as this is allowed by the prevailing system of farming. The production of green manure crops, both winter and summer, thus increasing the soil's organic content and its moisture-holding capacity, should be pushed vigorously. Contour cultivation must be encouraged, as this prevents the water from following ready-made channels such

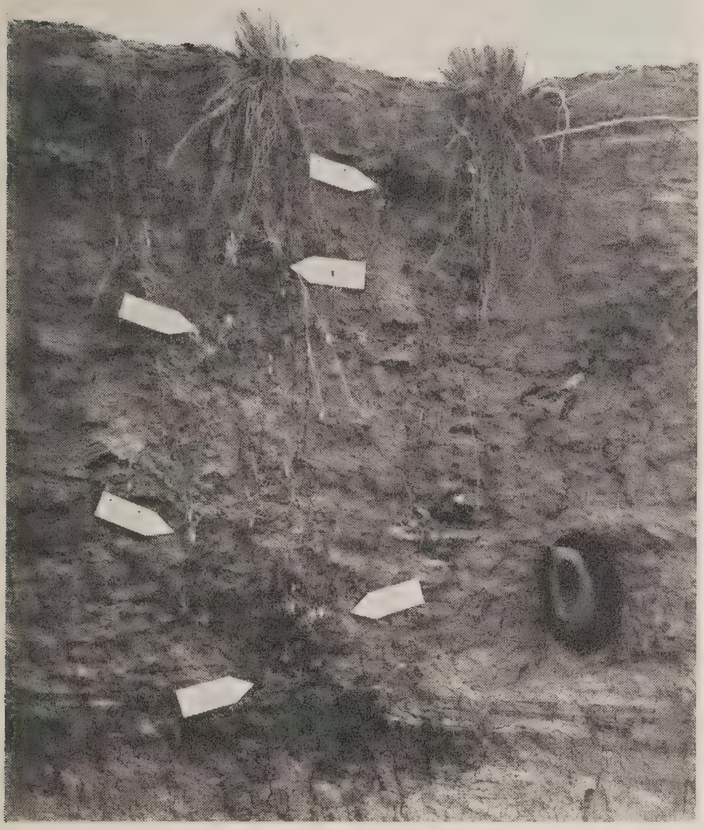
(Continued on p. 200)



Sage brush has encroached on the western range country until today it occupies millions of acres. Extremely close grazing of the grasses has encouraged this encroachment. While sage brush gives excellent cover, it greatly reduces the carrying capacity of the land and increases the grazing load on the remaining uninfested grasslands.

SILTING DID NOT DISCOURAGE THIS PLANT

By Evan L. Flory [1]



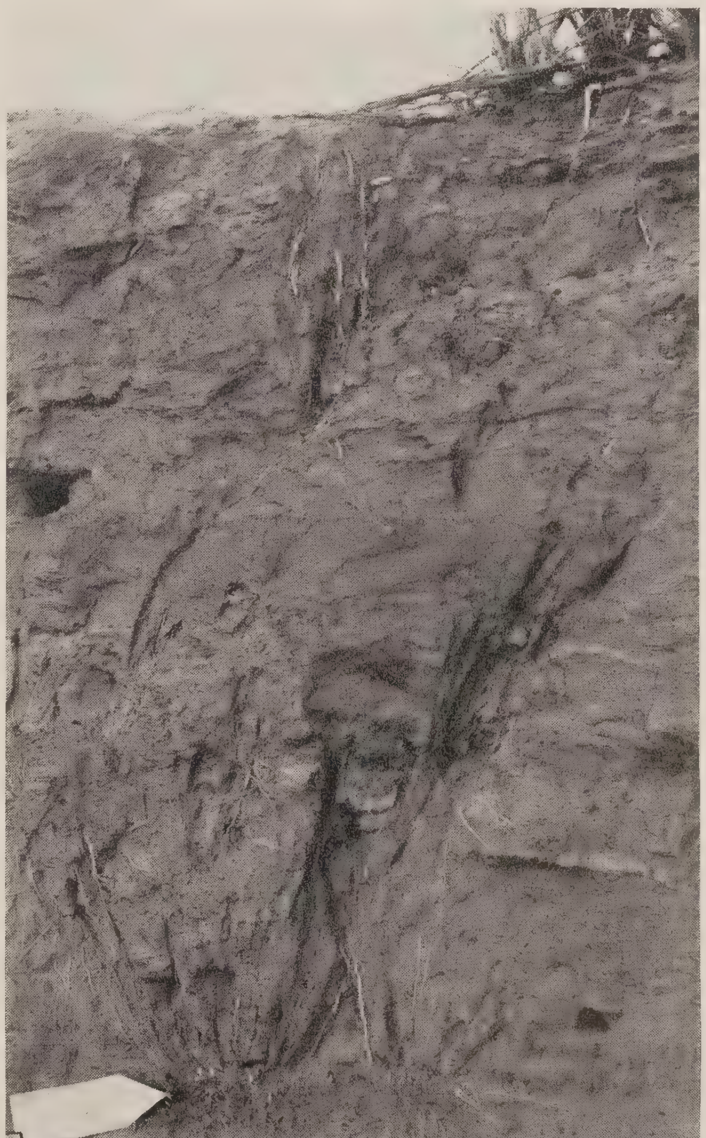
IN THE cut bank of an arroyo through an alluvial plain water and wind have exposed the root system of a sacaton plant (*Sporobolus wrightii*). In the picture at the left, the lowest dart, 6 ½ feet below the present surface, indicates an old soil surface. This surface was heavily vegetated, as indicated by the layer of rich black soil. Shortly before the first deposition of 8 inches the area was swept by fire as shown by the charred stems. What caused the deposition of silt is merely a matter of conjecture, but it is quite possible that the destruction of the cover by fire was responsible.

Burning and covering, however, were not sufficient to daunt the sturdy sacaton plant, as it was able to survive the covering and firmly established itself on the new surface. That it was the same plant could be readily observed by vestigial connective stems and roots.

At the right is a closer detail of another plant on the same level which shows the course of connection nearly to the present surface. Such connections are not so apparent in the first picture, but they were readily traced in the field to the two surviving plants shown on top of the bank. These two plants have survived three fires on the three lower soil surfaces indicated by the lower three darts. Six successive silt deposits of 9, 10, 26, 8, 8.5, and 14 inches, totaling 6.5 feet, failed to exterminate this plant. With the first and second covering the number of plants apparently increased because of the spreading top which continued to grow. The third and deepest deposition of 26 inches smothered most of the plants but a few were still able to survive.

How long a period has elapsed in this process is difficult to imagine, but at least three of the soil surfaces persisted long enough for fairly distinct zones of black earth to be formed. In a semiarid climate where the temperatures are high, evaporation high and rainfall less than 9 inches yearly, the formation of such humus layers could very possibly take several hundred years.

[1] Associate soil conservationist, Albuquerque, N. Mex.



FERTILE VALLEYS laid waste by Upland Erosion.

By Stafford C. Happ [1]

SEDIMENTATION in streams and valleys is a widespread natural process which rarely attracts the attention that its importance deserves. Running water tends to pick up sediment wherever soil and subsoil materials are exposed, and to drop this load farther downstream. The waters which carry and deposit the sediment catch the public eye, especially during floods, but the sediments themselves, even when exposed by receding waters, are soon lost to the casual view. Silt deposited in city areas by flood waters receives some attention, for it must be removed from streets, cellars, and buildings, but the vaster accumulations in valleys is given comparatively little consideration. Such deposits, as a matter of fact, frequently are regarded favorably because of their reported value in maintaining the fertility of such lands as the Mississippi Delta and the Nile Valley of Egypt.

Sediments consisting of sand and gravel are the more conspicuous, particularly when they block highways or railways, but even these are too often thought of as comparatively minor and incidental aspects of flood damage.

Reaching the Subsoil

Under conditions in modern, civilized countries stream and valley sedimentation becomes serious indeed. As a result of accelerated erosion of cultivated sloping lands from which the forests have been cleared, or of overgrazed range lands, the original fertile topsoils disappear down the streams toward the sea. More and more infertile and coarse subsoil materials then are carried into the streams by rain wash. The character of the sediment being deposited in and along the main streams thus gradually changes for the worse. Smaller and smaller proportions of plant-food material are included in the sediments periodically spread across the major valley bottoms by flood waters, and in extreme cases fertile valley soils are buried beneath sand and gravel.

As the sediment load carried by the rivers increases in quantity and in coarseness, the channels begin to fill and flood dangers grow worse. With the choking of drainage ways, bottom lands become water-logged and swampy, making cultivation unprofitable and often killing valuable timber. Dredged drainage canals are filled, and artificial levees are overtopped by flood waters as stream channels are built higher by deposition on their beds. Thus, obvious damage to costly improvements and property, and even danger to human life, is added to the more general but less conspicuous process of impoverishment of fertile valley lands.

The Soil Conservation Service is concerned with stream and valley sedimentation, both as a downstream effect of accelerated upland erosion, and because of the direct damage to major valley soils. Preliminary field work to obtain basic data on the problems and processes involved was begun late in 1935 by the Section of Sedimentation Studies, Division of Research. Since this is virtually a new and almost

[1] Project leader, Stream and Valley Investigations, Section of Sedimentation Studies, Division of Research, Soil Conservation Service.

1. Typical view of the badly sanded East Goose Creek drainage canal, in the Wells District.

2. Looking downstream from the head of the "sand plug" in East Goose Creek canal, about 1½ miles below site of picture 3.

3. Comparison in growth of cotton on sanded and unsanded parts of same field, such as occurs when sand is being spread across fields still kept in cultivation.

4. View of field partly abandoned to briers and willows, taken a few hundred feet from picture 1.

5. Raw sand spread among willow trees which have grown up in field abandoned about 10 years ago. This view is along West Goose Creek, near the head of a "plug" similar to that in picture 4.

6. Typically gullied old field in the Wells District abandoned about 10 years ago.

unknown field of investigation, attention has been directed chiefly to development of detailed research plans and methods of study. However, much significant information has already accrued. In the Wells drainage district in Lafayette County, northern Mississippi, for example, the data are revelatory of conditions which obtain in one of the areas investigated.

In 1920 about $30,000 was spent for construction of drainage canals in the Wells district, which includes

some 2,000 acres of bottom land on Tobitubby Creek. The district drainage commissioners originally estimated that these expenditures would produce benefits amounting to about $54,000. The work was financed by a $27,000 bond issue which was to have been retired by taxes totaling about $55,000, to be collected over a period of 23 years ending in 1943. Before the completion of the construction work it was found necessary to issue an additional $11,000 worth of bonds which would have increased the total cost to more than $71,000, but owing to legal complications the taxes assessed to cover this additional cost are not being collected.

Clogging of Channels

The need for drainage was due mainly to the clogging of stream channels by sand washed from gullies in the tributary uplands. However, the plans did not include any treatment of these sources of the trouble. Sand continued to wash from the gullies, and collected rapidly in the new drainage canals. Within 5 years, according to reports of local residents, the canals had ceased to function adequately. In 1927 the board of drainage commissioners of Lafayette County inspected the district and reported that work was needed to reopen the canals, but no funds were available for the purpose. Today, three-quarters of the canals are completely filled, and in many places are recognizable only as low ridges of sand. Because of the retarding effect of trees and brush along the banks, sand has been piled up in the channel in places nearly 2 feet above the level of the adjacent ground surface. The depth of channel filling has been found, by test borings, to be consistently greater than the original 8-foot depth of the canal. The surrounding ground surface has likewise been covered with sand deposits, to an average depth of at least several feet throughout the district.

Most of the remaining sections of the canals are so badly filled that they cannot provide adequate drainage. Filling apparently proceeds chiefly by upstream growth of a "plug" of sand. At the head of the section completely "plugged", the waters spread overbank, and drain down the valley through back swamps between the canal line and the valley sides. Considerable standing timber has already been killed by the rising ground water table in these back swamp areas, and they are totally useless for farming. At the head of the plug, and to a lessening degree from there upstream, frequent floods carry sand overbank and spread it across the valley bottoms. A little of this sand improves the soil texture, but unfortunately the accumulation generally continues much beyond this stage.

This process of sanding of the bottoms began long before construction of the canals, for it was described as early as 1860 by Dr. E. W. Hilgard, then State geologist. Local acceleration of erosion proceeding headward from the artificial ditches has been a contributing but not a principal cause of the excessive erosion and sedimentation. The ditches may have caused the area of most serious damage to be extended somewhat downstream, but at least most of the district apparently was doomed by the gullying of the upland, regardless of the drainage ditches. Of the present sand deposits outside the channels, which have been found to range in depth to about 10 feet, perhaps half may have accumulated before the canals were dug. Filling of the Wells drainage canals has been only an incidental feature in a century-long period of accelerated sedimentation, but the rate of valley filling was increased by opening of the canals. Because of the deposition of sand across the valley fields, many of these have been abandoned to brushy swamp lands and willow thickets, and during the past 10 years have yielded practically no revenue toward payment of the cost of the project. On one of the three main canals (East Goose Creek) complete filling of the channel progressed headward 1,650 feet between March 27, 1936, and February 2, 1937. Computed on the basis of average cost of the canals, including interest charges, this represents a $2,000 loss. For the canals of the 2,000-acre district, it is estimated that the destruction of invested values is now going on at a rate of at least $500 per month, exclusive of the loss in productive capacity of the fields served by these canals. Yet the taxes will continue, at least until 1943, to pay for canals already three-quarters buried in sand.

Causes of Sanding

The uplands surrounding the Wells district are covered with a brown silt loam of high fertility. Soon after the region was settled, about 1835, this brown loam soil became the basis of a prosperous agriculture. The upland soil was unusually well adapted to growing cotton, which has always been the important cash crop. On the other hand, the bottom lands along the creeks have always been preferred for corn, the staple food and feed crop of the country.

Once the forests were cleared, accelerated erosion began and quickly became a serious problem. The average annual rainfall is over 50 inches, and moderate

to rather steep slopes are prevalent. The region is physiographically almost fully mature, with local relief of 100 to 200 feet. Under such conditions, rain-wash erosion soon began taking a heavy toll of the soil. The erosion problem was accentuated by the common practice of "turning out" land which has begun to decline in production, while clearing other new fields. No effort was usually made to protect the "turned out" fields, and these became the prey of spreading and deepening gully systems.

The gullying has been especially serious because of the geological conditions. The district is in the Coastal Plain region and is underlain by the Eocene Holly Springs formation, which is largely composed of unconsolidated silty fine sands. The upper few feet of this sand is a reddish, oxidized, partly cemented zone (formerly considered part of the Lafayette formation) over which the brown silt loam is only 2 to 5 feet thick. Once the brown loam is washed off, the red Lafayette sand begins to be carried into the streams. Under primeval conditions the streams had adjusted their gradients to forested conditions when the sediment load was dominantly silt. These well-graded streams are not steep enough to carry much sand, and hence the sand accumulates in the channels. When further deepening of the gullies exposes the bedrock sands, the conditions become even worse. These unconsolidated sands erode very rapidly, largely by undercutting, and once they are exposed, gully control is very difficult.

Recent Cycle of Cutting

A significant factor in the situation has been the development of a system of arroyos trenching the head-water parts of the valleys. The term "arroyo" has not generally been applied to these incised, steep-walled, flat-bottomed, channels in which water flows only intermittently, but they are in every way similar to the typical "arroyos" of the Southwest. They reach a depth of 12 feet, and a width of 50 feet. The arroyo development has been a serious part of the erosional damage, both by the direct removal of cultivated valley land through growth of the arroyos, and by lowering the water table in periods of drought. The arroyos have also played an important part in the valley sedimentation, because their growth has added considerable quantities of sediment to the load of the streams farther down, and because they serve to carry vast quantities of sand and silt downstream from the gullies to the larger valley bottoms. If it were not for the arroyo channels much more of this sediment would have remained in the narrower and less valuable head-water parts of the valleys.

These arroyos have had a complex history, for in many places they are undergoing filling by accumulation of sand in the bottom of the channels. In places this sedimentation has gone so far that former arroyo channels are now completely filled with sand. In such cases, the process has apparently been essentially one of back filling, extending headward from the sanded valley bottoms at the arroyo mouths. Elsewhere the usual arroyo cycle, of deepening followed by widening, has been interrupted by a new period of down-cutting, so that small scrolls of flood plain, supporting trees at least 20 years old, occur within the main arroyo walls. These old flood plain remnants suggest a period of partial stabilization following an earlier cycle of excessive erosion. Numerous old, wooded, and largely stabilized gullies which occur in the region may likewise date from this earlier period of excessive erosion. According to opinion and report, such a period occurred as a result of abandonment of many fields during and just after the Civil War.

Stream Bank Erosion

Below the arroyos the intermittent streams have flat-bottomed, sanded, shallow channels. At least part of them have developed by filling of former incised channels of the arroyo type. As the streams which flow in wet weather are unable to transport all of the sand entering them from the gullies, the gradual accumulation of sand causes the beds to be built up. This ordinarily produces a tendency for a widening of the channel by lateral erosion of the banks, with resulting destruction of the bordering fields. In places where this form of erosion has been particularly severe, the channels have been widened to several times their usual width. Lateral erosion is most active on the stream beds, which migrate sideward and downstream by undercutting of the bank on the outer side of the bends.

Bank erosion has sometimes been inadvertently aggravated by cutting off the trees and brush which line the stream banks. This is usually done to reduce the length of periods of overbank flooding, by increasing the rate of flow in the channel. In one of the most striking instances observed in the Wells district, an attempt to obtain better drainage was made a few years ago by clearing the banks along the upper part of one of the canals. Today, this section is 35 to 40 feet wide where it was cleared, but the canal is only 15 to 20 feet wide for more than a mile downstream from the

quarter-mile section which was cleared. Above the cleared section the channel is even narrower. Over half an acre of the bordering bottom-land fields have been washed away in this one small section, due to the bank clearing.

Principles Hold Elsewhere

The history of the Wells district emphasizes the futility of attempting control of drainage and sedimentation problems without consideration of the upland erosion which is the fundamental cause. Because of the exceptionally severe upland erosion and the proximity of the district to the areas of most active gullying, the economic loss has been rapid and complete. The principles involved, however, are of much wider applicability, and deserve consideration of all agencies concerned in similar developments. Some erosion-control work has been done in the watershed by the Soil Conservation Service during the past 3 years, but much more will be required before there can be any hope of successfully reclaiming the bottom lands now swamped and sanded.

There is, however, another and perhaps equally important lesson to be learned here. It is obvious that some addition of sand to the prevailing heavy bottom-land soils is decidedly advantageous in improving the soil texture. Large quantities of sand are now in progress of transportation by the streams, and stored in the filled canals. Farther downstream are wide valley bottoms which would undoubtedly profit by some addition of sand to the heavy soil, provided adequate flood control and drainage could be established and maintained. Diversion of the sand across these bottoms would aid in preventing the choking of major stream channels by sedimentation farther downstream.

Conclusion

Thus, there is need and opportunity for improvement of the valleys, by some direct attention to the problems and processes of stream transportation and sedimentation. There appears to be a reasonable opportunity for combining conservation of upland soils with reclamation of valley lands. Much of the sand entering the valleys comes from gullying of the least valuable parts of the cultivated uplands, so that considerable economic improvement might be obtained by a readjustment of the present land-use practices.

From Farm Fields to City Streets

(Continued from p. 190)

tions have been made and no moisture determinations have been run on the samples. Therefore, I feel very reluctant to hazard an estimate on the amount of sediment that has been deposited in the cities. Nevertheless, by roughly scaling the flood areas of the principal cities and averaging the recorded measurements, assigning a probable weight per cubic foot based on the apparent degree of dryness recorded at time of sampling, some round figures can be obtained that should be within the order of magnitude, even though moisture determinations may finally change them as much as 50 percent.

These preliminary estimates are for the flooded areas and the amount of sediment, dry weight, deposited within boundaries of the following cities:

Cities	Area flooded	Amount of sediment
	Acres	*Tons*
Wheeling, W. Va	2, 145	130, 000
Huntington, W. Va	5, 780	215, 000
Marietta, Ohio	1, 152	110, 000
Portsmouth, Ohio	3, 060	100, 000
Cincinnati, Ohio (metropolitan area)	[1] 12, 800	500, 000

[1] Approximate.

The cost of clean-up work directly attributable to mud left in the cities will run into millions. The city engineer of Wheeling, W. Va., stated that after the flood in 1936, it took 1,500 men and 50 trucks 8 weeks to remove the mud and debris from Wheeling.

Looking at the situation in the flooded cities as a whole, it seems that conditions might be summed up thus: Millions of tons of soil lost in a single fortnight from lands that cannot afford it. Millions of tons of soil deposited in cities that don't want it. Millions of hours of labor spent in ridding cities of it. How much could we afford to spend to keep the soil where it ought to stay—or rather, how long can we afford not to?

In Region 11 more than 1,600 acres of waterways on agricultural land have been seeded and sodded by the Service. This treatment will prevent these areas from developing into gullies.

Although it is difficult to place a definite value on the utilization of crop residues, cooperating farmers in the Northwest estimate the gains from this practice at from $5 to $10 per acre, due to the prevention of soil losses.

LAGUNA INDIANS

Pin their hopes to *Better land use*

By Richard L. Boke

IN THE seventeenth century a small group of Indians broke off from the Pueblo of Acoma to establish a new village of their own, now known as the Pueblo of Laguna, on the tributary of the Rio Grande. Today the colony numbers 2,200, with seven compact rock and adobe villages scattered over 237,000 acres of tribal land. These Indians have become prosperous farmers, perhaps the most successful of the Indian stock raisers in the Southwest. The little flock of sheep which they brought with them now numbers 48,000.

As the pueblo grew and the herds increased, the land lost its thick cover of sacaton grass. From the valleys to the mesa top browse has become thinner, and erosion has ensued on every hillside.

Reaching Out for More Land

In order to keep his bands of sheep, the Laguna Indian has been forced to rely upon the grass, water, and soil outside his own area. He has leased and homesteaded more and more land, and has taken advantage of the great Spanish land grants scattered along the Rio Grande and its tributaries. But wherever he has gone it has become increasingly difficult to obtain sufficient grass and water for his flocks. He has noted the damage with dismay.

So clearly did he realize the situation that when the Soil Conservation Service in cooperation with the Indian Service came along in 1935 and told him that his land was overgrazed, his flocks were too large for his resources, and his children's land heritage endangered, he readily agreed to a 4-year reduction program. Under this he would reduce his flocks to the carrying capacity of the land. At the same time the Soil Conservation Service was carrying on an erosion-control program on the B. M. Montano area, an old Spanish grant of 44,000 acres which had come under the administration of the Federal Government through purchase.

Laguna herder and sheep on severely overgrazed area.

On the basis of surveys, the Service estimated that this grant would carry at the outset 3,000 head of sheep for 7 months out of the year and still improve in grass cover and erosion control if the sheep were properly herded and managed. To help out the Laguna Indian in his reduction program, the two Government agencies told him that he could graze 3,000 head of his sheep in 1935 and 1936 on the Montano grant. With this 3,000 the grant was properly used for the first time in many years. There is an abundance of forage under the better management system. There was less damage to the plants by trampling and congestion. The sheep were not kept thin by constant traveling in search of food. The Laguna lamb crop on this properly used area was over 95 percent, while for the same kind of sheep managed in the old way, it was only 65 percent. Each of the sheep wintered on the grant averaged a pound of wool more than those wintered on overused areas. The price obtained for the wool clipped from the sheep on the Montano grant was 23 cents per pound, while that for the same kind of sheep on depleted lands was 21 cents. The wool from sheep clipped on the grant was worth $1.60 per head, while that from the others was worth only $1.26.

Increased Returns

During the summer of 1936 the grant was not grazed, but was given a rest until August. Then 1,000 ewes with their lambs were returned to the area. At the time of marketing, the lambs from this flock overaged 64 pounds and sold at the rate of 7.25 cents per pound, while the lambs from the same kind of ewes raised on depleted areas averaged 47 pounds in weight and sold at the rate of 5 cents per pound. So in 1 year the forage on the Montano grant, due to proper use and proper management, made a difference in revenue of $2.25 per lamb.

On the ranges of the Southwest, erosion control depends fundamentally on proper use. The Laguna Indian has seen that less erosion and more grass and better sheep go together. In better land use lies the future of his agriculture and livestock, and therefore of his villages.

Agronomy's Contribution

(*Continued from p. 192*)

as are made by up-and-down hill tillage. The use of tillage implements that will provide for holding the water on the land should be encouraged.

On the millions of acres of pasture land, mismanaged for so many years, the program is naturally one of increasing the quantity and quality of vegetation. A heavy growth of grass offers excellent flood control because it minimizes the run-off. Pasture land, depleted of fertility, cannot be expected to produce a heavy growth of grass, particularly if it is continuously heavily grazed.

To reestablish good cover on pastures and ranges, it is necessary first to conserve the water that falls so that it can be utilized by the vegetation. This can be accomplished in large measure by the construction of contour furrows. Thousands of instances of the usefulness of contour furrows for this purpose are now in evidence throughout the country. Contour furrows, except in those regions where the lack of moisture is the only factor involved, cannot, however, make grass grow. There must be enough plant food in the soil to produce grass plants and this can be supplied in the form of fertilizer. Grazing practices, in most cases, must be changed, as grasses cannot stand continuous season-long grazing, year after year; they require an opportunity to store reserve food and to develop strong root systems capable of producing a dense growth in competition with less desirable vegetation.

(*Continued on p. 214*)

WEIGHING THE COSTS OF FLOOD CONTROL

By Walter J. Roth [1]

THE cost of floods in general may be computed in terms of the dollar value of damage to municipal and industrial property ranging from the dwelling and goods of the humblest householder to the property of the largest corporation. It will include damages to highways, bridges, railroads, communication lines, water supply, and like items; to agricultural property including farm buildings and lands, crops, pasture, livestock, forests, and wildlife.

The Task of Appraisal

Important in connection with the damage to property is the cost of the replacement and repair, of cleaning up, and of rehabilitation. Appraisals of this sort are relatively simple. Somewhat more difficult of appraisal but ranking as real costs nevertheless are the losses due to the interruption of activities of all kinds—factories, commerce, communication—and the loss of market connections, all of which result in a loss of income. Most difficult of appraisal but of extreme importance because of the many individuals involved and because of its poignant effect is the human suffering, the anxiety, the strain, the privation, the sickness, and often the loss of life. The appraisal of these costs is a difficult task calling for the best judgment of the engineer and appraiser alike; but it can be done.

Loss of Fertility

A phase of the cost of floods probably overlooked but very important from both the private and the national point of view is the loss of fertility and productive capacity because of erosion on tilled farm lands through soil removal from higher areas with subsequent redeposition on lower areas and in channels, ditches, lakes, and reservoirs. The damage is not alone to be measured in terms of the immediate loss to the farm or farms involved, but is to be measured also in terms of the lowered community productivity and declining income with the inevitable consequence of depopulation and economic and social disintegration.

As already intimated, the estimate of the cost of floods will vary depending upon their frequency, their intensity and duration. The frequency of floods, we are assured, can be decreased through appropriate and integrated means of control. Likewise, the intensity or duration can be modified. These concepts will be treated somewhat more fully in the paragraphs which follow.

The estimate of the cost of control is affected by the degree of control contemplated. Not only would complete control be more costly than partial control, but as efficiency advanced, costs would be accelerated. The question confronting us is not so much "Will it pay to control floods?" but rather "How far is it good business to attempt to control floods?"

The cost of control contemplated then hinges upon an appraisal of the engineering and other works deemed necessary to catch, hold, and drain off the expected precipitation. Whether these works be dams, levees, revetments, spillways or whatever type need not concern us here. It is sufficient for our purpose to point out the considerations lying behind the choice of the alternatives before us as individuals and as a nation.

Soil and Water Conservation

In consideration of the particular type of control to be adopted, serious thought should be given to the part which can be played in a program of flood control by the area-wide inauguration of appropriate soil- and water-conservation practices. Next to the oceans the soil represents the greatest natural water storage reservoir available to us. For much rain water which now runs off from the nonreceptive fields and farms to swell the streams to flood stage, the soil if appropriately treated could act as a "catch basin" and "delayed-delivery works", feeding the streams over a long period of time rather than in short, sharp, flood-inducing fashion. In this manner the minor flood crests could be reduced and their frequency decreased.

For heavier rains and rains of longer duration and volume now causing the "super-floods", even a complete soil- and water-conservation program cannot be entirely effective. However, this soil storage, coupled with appropriate land-use methods and properly designed channels on farm lands, can be expected to deliver the actual run-off in somewhat delayed fashion instead of the present pell-mell catapulting of excessive run-off into existing inadequate drainage systems. It is conceivable that in this manner even the larger floods could be affected though, obviously, in less proportionate degree.

(Continued on p. 207)

[1] The author is head of the Section of Economics of Soil Conservation, Division of Research, Washington, D. C.

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The TRAGEDY of WIND EROSION

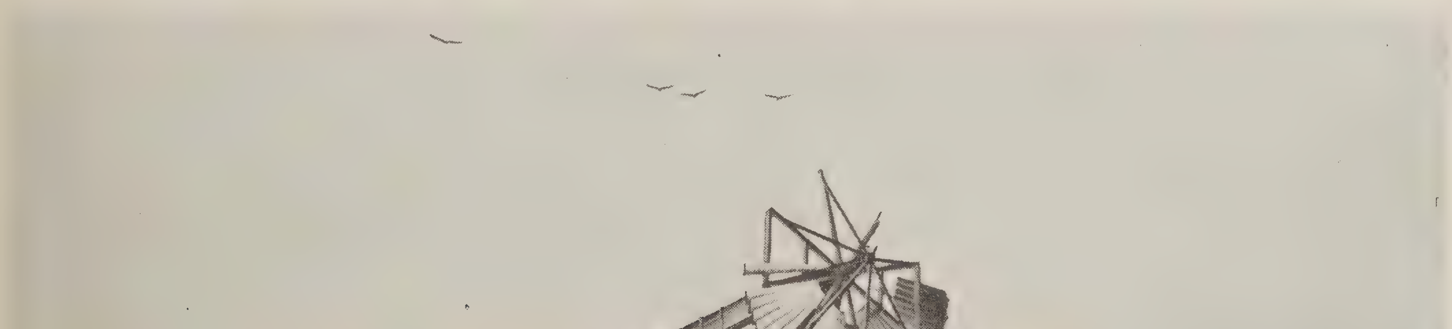
ON THIS and the opposite page are reproductions of three much-discussed canvases by the distinguished artist Alexandre Hogue.

The artist spent many years on a ranch near Dalhart, in the Texas Panhandle. His windmills ought to work, because of his personal experience in pulling sucker rods and pump pipes and replacing sections in the wheels. He calls himself a genuine "dust eater", saw the plow rip through fine garden patches and feed crops to prepare the land for wheat empires and eventual erosion. He favors the spelling "drouth" because it has an "earthy dryness" and is more easily pronounced.

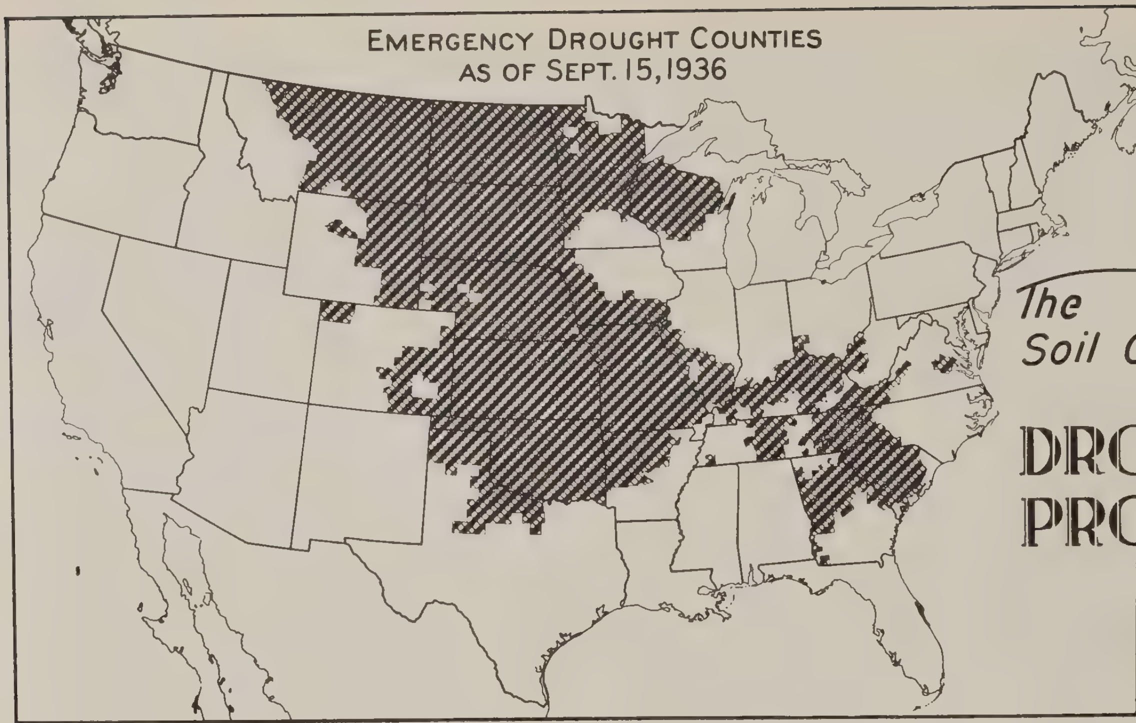
"Dust Bowl" appeared in a special edition of *London Studio* recently. This and companion pictures have hung in the Whitney Museum, the Boyer Galleries, and the First National Exhibition of American Art, in New York City; the Corcoran Gallery of Art, in Washington, D. C.; the Chicago Art Institute.

"Dust Bowl"

"Erosion" (tempera)



"Drouth-Stricken Area"



The Soil Conservation Service DROUGHT PROGRAM of 1936

By-W. F. Peel, Division of Operations

ON JULY 7, 1936, 97 counties were designated by the Department of Agriculture Drought Relief Committee as "emergency drought counties", and by the end of November this figure had increased to 1,194 counties located in 24 states. The program for relief as based on reports and recommendations of various Federal and State agencies served as a guide for all Government commissions in providing aid to farmers in drought-stricken areas. Because of the nature of the work of the Soil Conservation Service, that organization was in a favorable position to take over many of the obligations and technical directions necessary to a workable drought-relief program throughout the country.

Benefits to Large Acreage

The work of the Service has been concentrated chiefly in the most seriously affected areas in the Plains States and the regions east of the Mississippi River, with the result that approximately 2,900 erosion-control projects have been established. The acreage benefited is in excess of 1,430,000, and employment was given to 17,000 persons. Relief funds provided farmers with a source of income with which to purchase emergency rations and continue the operation of their farms. Through experience gained by taking an active part in the work program, the farmers will be able to carry out on their own farms the soil- and water-conservation practices made available to them by technicians.

A few of the major features of the program as established by the Committee will serve to show the main factors considered in determining the work areas:

1. Application to Interstate Commerce Commission for reduction of railroad freight rates for shipment of stock to more productive areas. Reduction of as much as 85 percent on outbound shipments and 15 percent on returned shipments of livestock were obtained.
2. Inauguration of a seed-purchase program whereby limited varieties of wheat, durum wheat, oats, barley, and flax, all adapted for growing in drought areas, were purchased and stored in granaries. In the spring of 1937 this grain will be sold to farmers in drought areas.
3. Shipment of food supplies and forage to drought areas.
4. Institution of a cattle-buying program in stricken grazing areas. Cattle were liquidated because of reduced supplies of forage and water. In most cases only a few milk cows and work horses were retained.

The work of the Service was to provide supervision, labor, tools, materials, and technical guidance in developing soil- and moisture-conservation practices on drought-stricken farms. In all sections of the United States which were designated for drought relief, the Service programs were so planned as to meet the individual requirements of the counties. The national program included the construction of dams, development of springs, surveying of contour lines, laying out of terraces, contour strip cropping, contour furrowing, gully control, approved rotations, establishment of erosion-resisting crops, the conversion of cultivated lands to permanent grasslands, terracing, lime-grinding, planting of winter cover crops, cleaning of streams and drifted fence rows. Cultivated fields were laid out in 10- and 20-rod strips at right angles to the prevailing winds. Shelterbelts were cleared of dead and fallen trees and brush. Protective belts of trees and wild game plantings were established in favorable locations, and abandoned rangeland was reseeded. Reports from two States indicate that approximately 70,000 tons of limestone were utilized, and of this amount the Soil Conservation Service ground 40,639 tons and burned 18,750 tons.

In the western area where whole States were designated for emergency drought relief, the situation called for the development of a water-conservation program of considerable extent. This included the construction of dams supplemented with dikes for water-spreading purposes. The construction of reservoirs for stock-water was fostered; and where possible, these dams were placed in strategic locations where they might serve the dual purpose of stock supply and flood irrigation. Reservoirs for stock watering were also located on stock trails, and it is expected that these will prove of great benefit when cattle are driven to shipping points.

Some dams were built for the purpose of benefiting groups of neighboring stockmen, while still other smaller dams were erected on areas controlled by grazing associations. These reservoirs were suitably located to provide uniform grazing. Water troughs were built below the dams, and fences put up around the fills. This program and the depletion of stock will allow natural reseeding of forage plants and will result in better grazing conditions. In Region 9 alone, approximately 410 drought dams were constructed. Larger dams placed near towns served in a few instances as main sources of water.

It is well known that a considerable portion of our range land has been ruined beyond repair because nutritious native grasses, adapted through centuries of

ever-recurring drought, have been destroyed and the topsoil blown away, exposing the subsoil which is unsuitable for plant growth. However, on the greater part of the western range remnants of the native grasses still manage to survive. The topsoil, though thinning through wind and water erosion, is still worth saving. Through the efforts of the Soil Conservation Service and associated agencies, controlled grazing measures are being adopted. It appears likely that, after a period of time, these lands can be restored to a condition similar to that of half a century ago. For our western range, it is hoped that there will be an expansion of the policy which provides for the adaptation of the economic life to a physical situation which cannot be materially modified because of the climatic conditions.

The fact that whole States in the West were affected by drought and soil erosion has caused the Service and associated agencies to give special attention to that territory, but this does not mean that there was no drought-relief work in other sections of the country. The program was broad in scope and the work was carried out in all States designated for such relief.

The educational value of the work already accomplished in drought areas is a factor that is well worth thoughtful consideration. Farmers have had the opportunity to practice control measures as demonstrated by the Service, and if these measures are followed up over a period of years they will prove their worth in reducing the destructive effects of recurring droughts. Through these examples of the value of preventive measures, with instructions for their application to individual problems, it can be expected that voluntary use of preventive methods will be adopted. That this is probable is indicated by the requests received from interested farmers in all parts of drought areas for a continuance of the program. Although the emergency which required extra effort appears to be mitigated for the time being, a program for permanent relief should be inaugurated for the situation which is well described by Stuart Chase in his Rich Land, Poor Land as follows: "As I wrote in July 1936, a drought which has already caused a billion dollars' worth of crop damage is searing the prairies, the Great Plains and parts of the South. The area most seriously stricken is on the one hundredth meridian in the Dakotas * * * Thousands of families, their wheat burned to brown stubble a few inches high, their cattle bellowing with thirst, their very homes made uninhabitable by dust and sand have commenced a great migration. * * *

"There is no reason to suppose that the climate in the West is changing. There is every reason to suppose that for thousands of years, cycles have moved from wet to dry and back again, that it has often been

just as hot as in 1934 or 1936, but never before has so much of the original grassland been in crops and never have natural reservoirs been so depleted."

Again, as this is being written, Nature is demonstrating by flood rather than drought what tragic consequences result when man endeavors to use lands for purposes and in ways that are not in accord with meteorological climaxes. Neither extreme dearth nor prodigality of water may be prevented by human efforts, and it would seem high time to recognize this fact by planning land-use programs that can be made to cooperate with Nature.

Costs of Flood Control

(Continued from p. 201)

Further aggravating the strain put upon the present drainage system is the contribution, through the medium of flood-water torrents, of silt and sediment from farm lands. This causes shoaling and filling of channels, ditches, lakes, and reservoirs, and makes ineffective their function for drainage or storage as the case may be. A soil- and water-conservation program could function to minimize further the damages of floods by reducing this silt and sediment in our streams.

An appraisal of the cost of control, in whatever degree this be contemplated, need not be increased by the total outlays for the soil- and water-conservation practices designed to reinforce the downstream engineering program with which it is to be integrated. The reason for this statement is the value of the soil- and water-conservation program to the farmer in improving yields and increasing income. This situation need not complicate the appraisal of the cost of the control program, but it should be taken into account.

While the cost of control, or an appraisal of its cost, is complicated by reason of the many estimates involved, further complication arises from the lack of adequate information concerning floods of varying intensities. Although this information cannot be obtained on short notice, considerable data in this field and in the general field of the energetics of water and silt will be forthcoming from the researches of the appropriate sections in the Division of Research in the Soil Conservation Service. Coupled with this data, of an engineering character, are necessary studies in effective soil- and water-conserving practices, together with other allied researches, including that in the economics of soil conservation and flood control. Such studies will give us a better factual basis for appraising the degree of control which will be effective at different times, under different conditions, and for different watershed areas.

Given such factual basis for the appraisals of the costs of control, the choice between the alternatives, floods or control, can readily be made. Based upon such research the question "How far is it good business to attempt to control floods?" can be answered with a high degree of certainty. In this scheme of things the Soil Conservation Service is destined to play a significant part in research and in actual control operations.

SAND DUNES IN THE GREAT PLAINS

By C. J. Whitfield [1]

IN RECENT years, as a result of cultivation, grazing and drought, sand dunes have developed on areas throughout the southern Great Plains, more especially in the region extending from the Canadian to the Arkansas Rivers. No more striking example of the destruction of land through man-induced wind erosion has been found. Under virgin conditions the topography of this region varied from nearly level to undulating or gently rolling, with good grass cover and no evidence of dune formation.

The dunes are of two types. The first and less extensive are the "blowout dunes" which develop around wells, or from roads and cattle trails. Blowout dunes seldom reach proportions equal to those of the second type, which develop as a result of wind erosion on land which through cultivation or overgrazing has been deprived of its natural cover. Both types of dunes generally are devoid of vegetation. They should not be confused with dunes which have developed as the result of wind action on outwash materials and which usually are found to be stabilized by native vegetation.

Studies Reveal Nature of Dunes

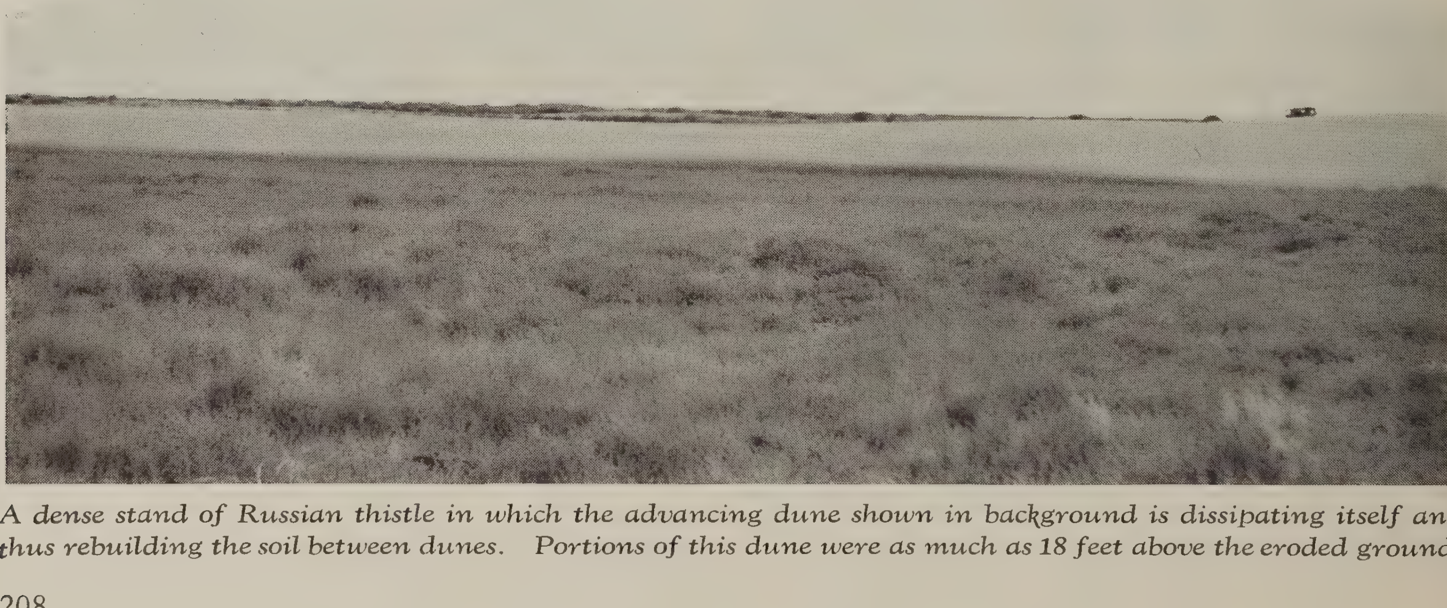
The dunes of which special studies are now in progress are on land that never has been cultivated. The sands were blown from an adjacent 80-acre area which was cultivated from 1907 to 1914 and then used for grazing. Evidences of dune formation were first noticed in 1926, but did not appear to be alarming until 3 years later. Since 1929 striking changes have occurred, with dunes developing from low mounds to heights of 26 feet. The dunes are large mounds of sand or sandy material, ranging from 50 to 880 yards long and usually about 30 yards in width. Apparently the height depends on the age of the dune and the direction and velocity of the wind.

Wind Has Clean Sweep

The substratum of the area on which these dunes are resting is very compact and fairly level. It consists of the subsoils of uncultivated land that has been eroded by wind to various depths, in some places as much as 4 feet. The border area is an ecotone or boundary line existing between the grassland and the eroded dune lands. Because of a hummocked condition, with the mounds of loose sand devoid of vegetation, and because it displays additional characteristics which apparently aid in dune formation, this border is designated as the "critical area." Here in this border area the wind sweeps unhindered across the hard lands, picking up materials as it goes.

One of the first things observed in studying these mounds of sand was that the large dunes move very

[1] The author is soil conservationist, Division of Research, Soil Conservation Service, Dalhart, Tex.



A dense stand of Russian thistle in which the advancing dune shown in background is dissipating itself and thus rebuilding the soil between dunes. Portions of this dune were as much as 18 feet above the eroded ground.

slowly if at all—a consequence undoubtedly of their crescentic shape. It was obvious that to prepare one of these large dunes for stabilization it was necessary first to reduce its height so that the wind would carry its load of material to the hard substratum beyond. In other words, the steep slope to the leeward must be eliminated. The method used for this was as follows: An 8- by 8-inch pole, of sufficient length, was dragged along the sharp edge of the dune. One to two horses are required to draw the bottom end of the pole, and two or three should be hitched to the top end. A disk attached at the top is an aid in breaking down the steep slope. Once a dune is broken down the wind cannot form eddies and the huge quantities of sand are carried beyond to another area and there spread over the substratum.

Dunes that have become compacted, due to rains and the trampling of stock, should be disked to facilitate their movement. As a result of the application of these methods dunes were lowered as much as 15 feet in a 5-month period. Once the steep slope is broken down, the sand must be kept in condition for blowing in order that the wind may carry it away. This may be done by using, at intervals as needed, a tractor and a small caterpillar terracer. In some instances a three-row lister has been used to advantage.

Plants to Hold the Sand

To hold the sand after it has been removed from the tops of the dunes to adjacent land, the exposed substratum included in our study area was listed and planted. No row crop was secured because the season was one of drought, but a profuse growth of weeds, especially Russian thistle, developed. Protection of the area by fencing and total exclusion of livestock undoubtedly aided this weed growth, although this factor was not totally responsible as the check plot did not produce weeds to any extent. Sand blown into such treated areas is generally caught and held by the plants, and thus it is that the substratum between dunes is given the opportunity to lay down topsoil.

Land Utilization in the Area

From the standpoint of proper land utilization, or the using of the dune areas under regulated grazing, it may not be necessary or desirable to destroy completely the dunes. In the study area, dunes 8 to 10 feet in height were planted to Kafir and Milo and good stands were obtained. It appears from the studies made thus far that dune movement can be controlled by planting quick-growing, stooling varieties of grain sorghums such as 60-day maize and other crops adapted to the region. During seasons of normal precipitation it is desirable to remove the tops of the larger dunes so that they are not more than 15 feet high. Proper land use of these dune areas undoubtedly lies in controlled grazing with only a small proportion (20 percent or less) of the land in cultivation.

Among the new publications of the Service is a bulletin entitled "Blue Grama Grass for Erosion Control and Range Reseeding in the Great Plains and a Method of Obtaining Seed in Large Lots" by Jess L. Fults, associate agronomist, Soil Conservation Nurseries.

View of dunes from top of a nearby dune. The dune in the foreground is small compared with others in the group. A strip of exposed subsoil in the foreground has been listed.

FARM PONDS PASS CRITICAL TESTS

By R. W. Oberlin [1]

Water flowing from pond through emergency spillway after a heavy rainfall. Such spillways provide protection for the dams from the torrential rains common in the Upper Mississippi Valley.

AS A RESULT of the 1936 drought, considerable discussion has taken place as to the feasibility of providing an adequate water supply on farms, especially in certain areas throughout the Middle West, by the construction of earth dams and reservoirs. It is realized, of course, that such a source of supply would not be practicable in areas where the soil is of a type to permit impounded water to seep away through the subsoil. There are other large areas, however, where the subsoil is of such a nature that the infiltration rate is relatively slow, and it is on these locations that earth-dam construction is desirable.

A Representative Area

One such suitable area is that of north-central Missouri and south-central Iowa, of which the Big Creek demonstrational area is representative. This is located in Harrison County, Mo., and Ringgold and Decatur Counties, Iowa.

On this project a large number of earth dams have been built primarily as an erosion-control measure. They also serve, however, to store water and furnish a source of farm water supply. Because of the attention that this type of structure has received, a survey was made covering 47 earth dams to determine whether or not they are adequate to provide an ample supply, especially during periods of extreme drought. Ponds were selected which were known to be full prior to the beginning of the dry period, and a rather detailed survey was made just before the drought was broken, in an attempt to determine the effect of severe drought on pond water.

Storage Capacity of Ponds

As a result of this survey it was found that these ponds had a total storage capacity of approximately 2,700,000 cubic feet, or an average of 59,000 cubic feet each. Their average drainage area was 8.9 acres. At the end of the drought the 47 ponds contained 1,361,000 cubic feet of water, or approximately 29,000 cubic feet per pond, which is about one-half their total storage capacity. The drought resulted, therefore, in the loss of 1,400,000 cubic feet of water through seepage, evaporation, or stock use, and also resulted in a lowering of the water level below the bottom of the spillway an average of 2.7 feet per pond.

Year-Round Stock Water Supply

Thirty-four of the farmers in this section use the ponds as a stock water supply, the livestock totaling 1,677 head. Approximately one-third of this number use the ponds for this purpose throughout the year, while the others use them only during the summer. One man reported that his pond was his only source of water for his stock, and several said they would have been forced to sell their stock had it not been for the ponds.

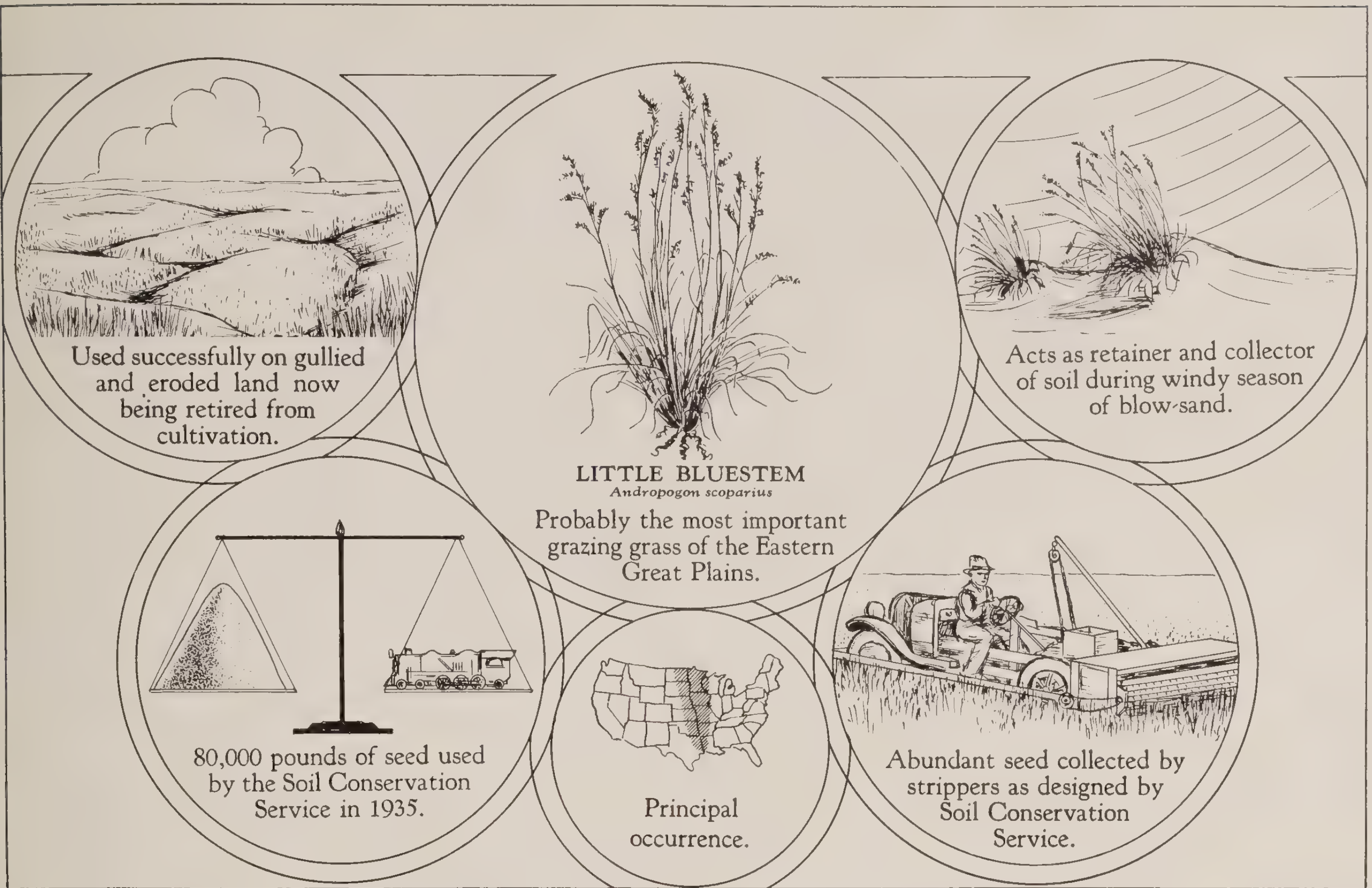
In addition to the individual use of the ponds, several instances of neighbors' using them for a stock water supply were discovered. One farmer was supplying neighbors with 1,200 gallons a day, while another said that 5,000 gallons a week were being hauled from his pond.

Twenty-four of the ponds are fenced to keep out stock, the fences being recommended also to protect the dams. Where a pond is fenced and used for stock water, it is advisable to insert a pipe through the base of the dam with an intake in the pond. The lower end of the pipe should be run down to a tank, and the flow of the water regulated with a float.

Ponds Have Many Uses

The ponds are an important factor in the program of wildlife conservation. Wildlife plantings have been made around 12 of them, and in 26 ponds water plants are now growing. Fish have been placed in 26 of them, and a number of farmers reported that these

[1] Regional engineer, Soil Conservation Service, Des Moines, Iowa.



bodies of impounded water are attracting wild ducks and geese.

Interesting miscellaneous uses of the ponds were noted during the survey. Two ponds had supplied ice to the farms, one farmer reporting a harvest of 40 tons. Another used his as a water supply for washing his car, while a third found his of value for the family laundry. Domestic waterfowl were seen on several ponds, and in many localities the water was used for the chickens. Almost one-third of the ponds were considered as neighborhood swimming pools, while one was used for baptismal purposes by a church in a nearby town.

Built with Trawler-Type Tractor

The ponds under discussion were built in Grundy, Shelby, and Lindley soils, all of which are particularly adapted to this type of construction. A crawler-type tractor with trail-builder attachment was used for the work which averaged approximately 1,200 cubic yards per dam. The average construction time per dam was 31 hours. The smoothing over of the dams was done by cooperators and in some instances by the C. C. C.

Remarks such as "The pond is a big help" and "This time the pond came in awfully handy" are indicative of the attitude of farmers regarding the construction of earth dams and reservoirs to provide adequate water supply on farms. Not one of the cooperators indicated that he was dissatisfied with his pond, and several said that they would like to have one or two more.

Demand for Earth Dams

As a result of this survey it can now be stated conclusively that an earth dam, properly located, constructed, and maintained in soil suitable for such construction, is a reliable source of water supply, even during periods of extreme drought. Many dams other than those included in the survey have been built, and the demand for their construction continues. The cost, compared with that of drilled wells and pumping equipment, is satisfactory. In the future a large number of these earth dams undoubtedly will be built, not only as an erosion-control measure but also as reliable sources of water supply for stock.

Retiring from cultivation all badly eroded submarginal lands and planting them to either grass or timber is an effective means of securing best land utilization.

TREES FOR CASH AND CONSERVATION[1]

By Leroy Frontz [2]

Portion of woods plot at Northwest Appalachian Soil Erosion Experiment Station from which soil and water losses were measured.

EXPERIMENT and experience have shown that ungrazed, unburned forest is an excellent conserver of soil and water. The interlacing branches and twigs break the fall of rain, lowering it more gently to the soil beneath. The roots of trees penetrate the soil to a greater depth than those of most other plants. When trees die the roots decay in the soil, leaving channels through which surface water is rapidly carried. Later much of it reappears in the form of springs. The mass of decayed and partially disintegrated leaves and twigs on the forest floor acts as a sponge, becoming saturated during wet periods and giving off moisture slowly during dry periods. The intertwining surface roots, combined with forest litter produce a condition under which it is practically impossible for soil losses or rapid run-off to take place.

The forest is the natural home of most game animals and birds. It may also furnish ample syrup, sugar, nuts, medicine, and other articles of everyday use. To a limited extent it affects the climate of the immediate vicinity. The protection and added comfort resulting to the average farm home by its presence cannot be measured in dollars and cents.

Know the Problem

Properly managed and protected woodland on the farm has a definite place in proper land use and soil and water conservation. The first step is to know the problem, a partial explanation of which is shown by economic surveys of land use in Region 3, comprising the States of Michigan, Ohio, Indiana, Kentucky, and Tennessee. The data are not to be misconstrued as argument for retiring every acre to forest.

Summaries show that of every hundred acres in farms, 11.5 acres are classed as woodland grazed and ungrazed. Ten additional acres are idle, waste, lanes, and building sites. It is estimated that an average of 3.5 acres are devoted to building sites and lanes, leaving a total of approximately 18 percent of the average farm area that is producing relatively little or no income. Further, 82 percent of the average farm area provides the necessary income to pay carrying charges and taxes on the nonincome producing portions of the farm.

Profitable, Too

Our studies have shown that in order to maintain the farm as a long-time profitable unit most of this 18 percent now classed as waste must be established and kept up in the form of well managed and protected woodland. There is but one way to accomplish this—the landowner must be shown how the woodland cover may be maintained and at the same time made to produce revenue.

Examples of farm woodlands in which some type of management has been practiced and in connection with which records of yield in forest products or money are available indicate what can usually be accomplished.

[1] Acknowledgment for data in this article is made to the following: F. D. Dean extension forester, Ohio State University Experiment Station; T. E. Shaw, extension forester, Purdue University, Lafayette, Ind.; U. S. D. A. Bulletin no. 1680, Farmers in Northern States Grow Timber as Money Crop.

[2] Forester, Soil Conservation Service, Dayton, Ohio.

Relatively speaking, the properly managed farm forest will yield an annual or periodic income comparable to or in greater amount, over a period of time, than that obtained from other crops grown on farms in Region 3.

Retired to Forest

Under the Service program, the poorest, steepest, most eroded soils on farms are those which will be retired to forest. Farm forests already existing are, for the most part, located on such areas. A study of fuel wood, lumber, and fence post prices indicates that, on a basis of a yield of one standard cord of wood or 300 board feet of saw lumber per acre per year in the region, the net income to the owner after labor and taxes are paid will be from \$2 to \$6 per acre per year. This net income from the woodland will continue so long as it is properly managed and protected from fire and grazing.

A study of a 25-year old black locust plantation located near Maysville, Ohio, shows a total money yield of \$374.25 per acre for fence posts and fuel wood, or \$14.97 gross per acre per year. Deducting for taxes, labor, and carrying charges, it is found that a net return of approximately \$10 is realized.

The experience of Harvey Floyd whose farm is near Blue Rock in Muskingum County, Ohio, indicates the relationship between profitable farm operations and woodland. In 1918 Mr. Floyd purchased his farm at sheriff sale for \$1,500. This farm is typical of southern Ohio land in that part of it is bottom land and the remainder relatively steep hillside. The only building on the farm at the time of purchase was a house in need of repairs and improvement. The former operators of this farm had starved out as a result of poor land management. Mr. Floyd decided that it was a waste of time and effort to attempt to cultivate the steep hillside fields. Those fields that had been cleared he seeded to pasture, and the others he retired to permanent woods. He concentrated on growing cultivated crops on the level bottom land. Lime, fertilizer, and manure were applied to the crop fields and pasture, with the result that today he is one of the most prosperous and successful farmers in his locality.

Good management and effective land use constitute the foundation of Mr. Floyd's success, but back of this highly important phase is his woodland. Even at the outset the original woodland on the farm, occupying a portion of the steeper hillsides, was put to use. Mr. Floyd rented a portable sawmill and from his woods cut sufficient lumber to build a barn, a shed, a hog pen, and a chicken house necessary to his farm business enterprise. The remainder of his lumber was sold at a profit to him of \$2,000 which more than paid his original investment. The actual profit provided money for the purchase of lime and fertilizer essential to crop production.

During a period of 24 years, the 75-acre farm woods of Ami Pifer in Hancock County, Ohio, yielded from the sale of saw logs and fuel wood \$11,250, or an average of \$6.25 per acre per year. Value of fuel wood, fence posts, poles, and lumber used on the farm was adequate to pay for labor and carrying charges. This woods has always been protected from grazing and fire, permitting young trees to develop to replace those removed in lumbering.

The intimate relationship down through the years of the farm woods to farm business and to good land management is illustrated by the John David Groves farm near Rome, Ind. Mr. Groves' ancestors settled there in 1807 when the entire land area was covered with forest. Sufficient white oak and tulip lumber was cut to construct farm buildings. The surplus was rolled into piles and burned. Clearing proceeded for crop production on the level first and second bottoms. The hill land, amounting to about 200 acres, was kept in timber. At present approximately 373 acres in bottom land is farmed.

Prior to 1870 no thought of protection or management was given the woodland portion of the Groves farm. The woods contained a large number of beech and oak trees, producers of mast. The grazing of hogs and cattle in the woodland was a common practice. With the passage of time, however, a constantly decreasing amount of grazing has been permitted in the woodland, until today it has been practically eliminated.

Building Needs Supplied

Throughout all these years the necessary lumber, posts, and fuel wood required for the development and maintainance of the Groves farm has been secured from the farm woods. In addition, considerable money has been realized from the sale of timber products and fuel wood. There are now in use on this farm three houses, five barns, and six sheds in the construction of which about 225,000 board-feet of home-grown lumber was used.

According to Mr. Groves, the net cash value of the woodland has amounted to about \$5.60 per acre per year. In addition to providing cash, the forest furnished timber and other products, thus enabling Groves to meet promptly unforeseen emergencies

(Continued on p. 216)

A NEW MACHINE FOR SCARIFYING TERRACE CHANNELS

By William A. Weld [1]

A SCARIFIER for use in conjunction with regular terracing equipment has been designed by the engineering staff of the Reedy Fork project in North Carolina. This attachment breaks the hard subsoil left by the grader blade simultaneously with construction of the terrace.

During the construction of terraces for erosion control, hard subsoil is often encountered and left exposed. This condition is most noticeable in the channel section of the terrace where the deepest cuts necessarily are made.

Hard Subsoil Undesirable

The smooth, hard surface of such soil, comprising a strip 8 to 12 feet wide the entire length of the terrace channel, is most undesirable for soil and water conservation, as well as for cropping.

The absorption of run-off water is greatly retarded by the impervious condition of the subsoil. It is, furthermore, most difficult to establish any type of vegetation on that portion of the terrace. Very few farmers in the Reedy Fork section have the power or equipment to break the subsoil thus left exposed.

It was to help remedy this situation that the scarifier was designed. As shown in the accompanying picture, it is mounted as a rigid attachment at the rear of the terracing machine. It can be operated very conveniently from the grader platform.

Scarifier Breaks Subsoil

A feature of this unit is that no additional rounds are necessary to accomplish the desired results. By merely lowering the scarifier, the subsoil left exposed by the grader blade is broken to a depth of 6 to 9 inches simultaneously with the back-sloping and cleaning out of the channel.

The scarifier makes it possible to establish a growth of vegetation over the entire terrace, and the water-holding capacity of the terrace is greatly increased.

This unit has proved helpful also in the construction of terrace outlet channels where vegetation is desired. By scarifying the channel bottom during the final grading operations, a very satisfactory seedbed is obtained at surprisingly low cost.

[1] Assistant agricultural engineer, region 2, Soil Conservation Service.

Scarifier attached at rear of terracing machine, thus enabling one man to operate both. Scarifier block elevated by means of lift arms to hold teeth clear of ground when not in use.

Agronomy's Contribution

(Continued from p. 200)

The advantages of deferred and rotation grazing in maintaining sufficient feed for drought periods are recognized by the farmers in some sections of the country. In the mountain valleys of West Virginia and western Virginia, for example, it is customary to allow Kentucky bluegrass pastures to make a considerable growth in the spring before stock are allowed to graze upon them. This growth of grass is generally not consumed until the dry period of the summer, usually July or August. This system of deferred grazing is one method of producing reserve food.

Lighter grazing of pastures than has been customary during the past is one protection from flood and a reserve against drought. Many of our western ranchers have learned the value of a reserve stock of feed produced during good years and stored in stacks, trench silos, and by other means. During the drought last summer, some ranchers were feeding oats and other feeds produced and stored as far back as 1932.

The agronomists and range men can contribute to both flood control and drought relief by encouraging (1) the production and storage of ample feed to relieve grazing lands in times of stress; (2) the use of proper cultural practices on tilled fields to conserve both soil and moisture; (3) the use of cover crops, strip cropping, and crop rotation; (4) proper grazing practices on permanent pastures and the production of supplemental grazing crops; (5) the use of adapted varieties of crops; and the encouragement of a well-rounded agronomic program based on proper land use that will help maintain the organic matter and the fertility.

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

EFFECTS OF THE GREAT DROUGHT ON THE PRAIRIES OF IOWA, NEBRASKA, AND KANSAS. By J. E. Weaver and F. W. Albertson. University of Nebraska. October 1936

The authors present in detail the results of studies made to determine the effects on vegetation of the most severe drought ever recorded in the prairies of eastern Nebraska, western Iowa, and west-central Kansas—that of 1934. The areas included 30 or more tall-grass and mixed prairies. The studies involved careful investigation as to the relationship between root depth of prairie grasses and forbs and their resistance to drying, and also examination of soils to determine available water content at various depths throughout the drought period. Lists of native grasses that entirely or almost entirely disappeared during the drought and native forbs that increased in abundance are given. Weeds which spread widely in periods of high winds are also listed.

In the tall-grass prairies it was found that while understory plants suffered great losses and in many places were entirely destroyed, some of the native grasses made decided increase in spread and growth. Wheatgrass (*Agropyron smithii*) in particular became widely established and now thrives in many places where the bluestems have died, especially in areas which had been greatly disturbed by accumulations of dust. Its vigorous growth during early spring months and its migration by long, slender rhizomes proved distinct assets for reclamation of land from which basal cover had almost or totally disappeared. Important potential centers of wheatgrass are now common on upland prairies and even more abundant on lower ground. Other native grasses showing increase as a result of extermination by drought of their taller competitors are the buffalo grass (*Bulbilis dactyloides*), blue grama (*Bouteloua gracilis*), and the 6-weeks fescue (*Festuca octoflora*).

In many areas of the tall-grass prairies, weed invasion has become a serious problem since the drought. The wild asters, catchfly, and many of the bulbous weed plants occur now in great abundance on areas which were completely or partially bared by drought and dust. Often they are the only plant species surviving over tracts of considerable size, giving the land the appearance of a series of abandoned farms.

The mixed prairies studied cover a rolling topography in west-central Kansas and border the valley of Big Creek which is a branch of the Smoky Hill River. Changes in vegetation cover as a result of drought were studied intensively by means of some 160 permanently established quadrats, as well as by observation and estimates over the whole area. An interesting series of charts included in the paper shows changes in vegetation as the result of cover by dust, soil-moisture loss, and grazing. Extensive data are given to show that little bluestem, the dominant type for the mixed prairies, suffered great losses even when protected from grazing and especially during the later periods of the drought when the reserve water in the pockets and crevices of the rocks was exhausted. This grass, handicapped by a shallow root system, suffered losses to the extent of 90 to 100 percent where it was mixed with short grasses. It was replaced to some extent by slender grama, big bluestem, and species of *Sporobolus*, but even at that much of the soil surface was left bare.

The short-grass cover which was protected from grazing during the drought displayed relatively small losses, although many forbs were either partially or completely eliminated. This resulted in an increase in the numbers of certain native forbs of greater drought resistance. In the lowlands, where soil moisture was not generally depleted until late in the period of drought, the forb population remained practically unchanged.

In the west-central part of Kansas, where drought conditions were most severe, ungrazed prairies lost 85 percent of their basal cover, moderately grazed areas 72 percent, and heavily grazed prairies 91 percent.

OUR NATURAL RESOURCES AND THEIR CONSERVATION. Edited by A. E. Parkins and J. R. Whitaker. New York and London. 1936.

This symposium, considered as a whole, presents a balanced, concrete view of the resources and conservation problems of the United States. Each of the 20 authors is a specialist in his particular field, and all write in support of the important central idea—that we must eliminate waste in the use of our soils, our waters, our forests, our metals and fuels, our wildlife, and the human life and culture of our nation. On the assumption that the remedy for waste lies in the education of all the people with regard to the genesis and nature of resources, the changes which they undergo when utilized, and practical methods which can and must be employed to offset deleterious changes, the plan of the book aims toward description of conditions as they exist today and as they point to urgent need for conservation.

The book contains a great deal of material of value to the student of soil conservation whatever may be his special field of work. The long article by Dr. Bennett, Soil Erosion and Its Prevention, in particular, points out the many and interdependent processes involved in the study of soil-erosion control. He emphasizes also the broad field for investigational work in accelerated erosion on the several thousand distinct soil types of the United States. "None too much is known about the mechanical relation of such activities as gravitational creep, sliding, fragmentation, granulation, and dispersion to processes and rates of run-off and erosion. The causative processes involved with the formation of V-shaped gullies, as distinguished from U-shaped gullies or gullies that spread faster laterally than longitudinally, have not been adequately investigated. Differential erosion on exposed sections of soil profiles characterized by markedly different horizons is a phenomenon that lies rather completely outside the knowledge of most specialists. Very little is known about the dynamics of rill washing. The baffling contrasts revealed in measurements of run-off and erosion from plots occupying the same kind of soil, the same degree of slope, and subjected to the same cultural treatments, would seem convincing evidence that the mechanics of loading and unloading on the part of thin and thick sheets of water flowing across slopes of different cross-sectional dimensions is little understood."

These special studies, and many others regarding climate and vegetation cover, must be carried out—with control of accelerated erosion definitely the goal. Tables included in Dr. Bennett's article

show soil and water losses under various crop or cultivation treatments; effect of forest cover on erosion and run-off, as compared with grass; soil and water losses from soil and subsoil of important types originally the same; comparison of soil and water losses under crop rotations on eight important soils; and effect of length of slope on erosion and run-off.

In discussing the problem of the arid and semiarid lands of the West, Ralph H. Brown of the University of Minnesota emphasizes the necessity for improvements in irrigation practices to minimize water losses through this practice. An accompanying article by Shelford and Hanson sets forth recommendations for restoration of perennial grass cover and rodent control in the grasslands.

In an unusual and illuminating article, Reclamation of Wet and Overflow Lands, George J. Miller states that "the assumption that any wet, swamp, or marsh land is suitable for agriculture when drained has led to the undertaking of many unwise drainage projects, and consequent disappointment and loss. Some of these enterprises should be abandoned and the swamp land utilized for more appropriate purposes such as forests, wildlife refuges, or marsh hay land * * * Further developments should be based on clearly demonstrated need for cropland, public welfare service such as maintenance of health and prevention of floods, ample evidence that the probable returns from drainage will warrant the investment, and careful consideration of the possibility that the wet lands, especially swamp lands, may not really be worth more to man if left in their natural state."

Many other phases of the subject of conservation are treated in the book—floods and flood control, wildlife, waterways and water power, forests and tree crops, mineral resources, natural resources and the manufacturing industry—and the present conservation movement in America is set forth as a field of national endeavor and long-term planning.

The book contains many illustrations, reference maps, agricultural data in tabular form, bibliography and index.

AN OUTLINE OF GENERAL FORESTRY. By Joseph S. Illick. New York. 1936

It is gratifying to note that this handbook has been brought up to date with new chapters dealing with special forestry activities in the general soil-conservation program. With stress laid upon the importance of tree plantings on eroding steep slopes, in gullies, on stream or road banks, and on depleted lands removed from cultivation, the general information concerning the many phases of forest maintenance becomes increasingly valuable.

The handbook is designed primarily for students of forestry, but it may also be of service to laymen and untrained forest workers engaged in a wide range of forest activities. Of interest are the chapters on the general forest situation in the United States today, and progress in State and Federal forestry. Within the latter is to be found an outline of the principal forestry activities of the Soil Conservation Service, including woodlot improvement, reforestation for erosion control, nursery operations, seed collections, and protection against fire, insects, diseases, and other destructive agents.

The general information concerning production and care of forests, equipment, management and utilization of forest products, and forest research, is systematically outlined and assembled. For the benefit of students of forestry the author has included a section dealing with forest education and fields of employment in forestry.

GEOGRAPHY, AN INTRODUCTION TO HUMAN ECOLOGY. By C. Langdon White and George T. Renner. New York and London. 1936

A new book on the study of human groups and their relationships to the earth. The various elements of the natural environment are presented, together with a general evaluation of the part each plays in human ecology. Beginning with the climatic factor, each climatic type is treated with regard to distinguishing characteristics, regions on the earth's surface, plant and animal geography, distribution of population, and economic, social, and political economy. The text contains chapters on soils and their characteristics and uses, with sections dealing with the problem of soil erosion and depletion and methods of control.

The book contains over 300 illustrations.

GOVERNMENT PUBLICATIONS AND THEIR USE. By Laurence F. Schmeckebier. Washington. 1936.

A guide to the utilization of Government publications with specific descriptions of catalogs and indexes, bibliographies, and classifications. Contains information concerning the availability of publications dealing with foreign affairs and relations, reports on operations of departments and bureaus, organization and personnel, and technical subjects. A comprehensive chapter on map collections is included Appendix contains a list of the depository libraries of the United States.

Trees for Cash

(*Continued from p. 213*)

such as continually arise in carrying on farm operations. Mr. Groves states that it is impossible, for such purposes, to place a dollar-and-cents value on the farm woods.

A study of the 150-acre woodland on a 200-acre farm in the Bedford, Ind., watershed project area indicates a possible net return of $8 per acre per year based on present growing stock and market prices. The total labor earnings for this farm, for 1935 and the preceding 10 years, amounted to about $242.94 per year. The woodland was used only for limited grazing and fuelwood production.

Under the reorganization plan for this farm, as prepared by the Soil Conservation Service, 150 acres has been set aside as permanent protected woodland. The estimated increase in income from better crop and pasture-land management on the 150 acres so used amounts to about 59 percent. This increase, added to that resulting from woodland-management practices, indicates a total labor income (in sight) of $1,500 per year, or more than five times that secured prior to the replanning of this farm by the Service.

U. S. GOVERNMENT PRINTING OFFICE: 1937

RECENT PUBLICATIONS ON SOIL CONSERVATION, FLOOD CONTROL, AND RELATED SUBJECTS

Compiled by Mrs. Etta G. Rogers, Publications Unit

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Soil Conservation Service

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[1] Payable to the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

MANY LANDS FURNISH PLANTS USED IN EROSION CONTROL

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

APRIL 1937

CONTENTS

EDITOR'S NOTE.—This issue of the magazine is something of an innovation. It serves to open a window on the broad panorama of research, without which the work of the Soil Conservation Service would lack foundation. The Climatic and Physiographic Investigations with which it deals constitute one of the several important groups of studies conducted by the Division of Research. ¶The major responsibility for the planning and assembling of material in this issue devolved upon Miss Lois Olson, in charge of the erosion-history unit. ¶In later issues other windows will be opened, further insight given into the fundamental programs of the Division.

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WELLINGTON BRINK — EDITOR

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A Foreword to THIS ISSUE

by W. C. Lowdermilk[1]

THE Nation has paid heavily during the last 9 months in relieving the distress and repairing in small part the damage wrought by a major drought and a record-breaking flood. Soils are wasting at perilous rates from thousands of sloping fields. Duststorms have left disease and destruction behind them. Silting of streams and reservoirs has become an acute problem.

REHABILITATION of the land constitutes a vital national cause, the success of which calls for the combined effort of agencies concerned with agriculture, forest industry, education, flood control, and national planning. Prompt and effective action is necessary to conserve our soil and water wealth. Accomplishment of the objective requires that each farm or tract needing treatment be managed in the interests of a permanent and sustained agriculture.

RESEARCH in soil conservation must explore the nature, causes, and effects of soil and water wastage under necessary agricultural pursuits. It must determine and test fundamental and practical means of preventing undue wastage and the feasible restoration of resources incident to sustained and needful land use. It must bring to bear upon the problems involved several fields of science and practice, and call into cooperation the agencies concerned with these special fields. It must plan and carry out, in cooperation with State experiment stations and other appropriate scientific and technical agencies, a program of research in erosion and silt control, soil and water conservation, and determine their suitability to serve the progressive needs of agriculture. In fulfilling these functions, research must serve the present and future needs of the farmers of the Nation, and contribute to the sustained use of land and water resources by furnishing to field operations of this Service and of other agencies tested and reliable information.

A COORDINATED attack is the policy of the Soil Conservation Service in its field operations. So is it equally the policy in its research to bring to bear upon the complex phenomena of erosion and its control the necessary fields of science and practice for solutions to the multitude of problems which are arising in the search for a permanent agriculture on the Nation's farm and pasture lands.

[1] Associate Chief, and Acting Chief of Division of Research.

THE RESEARCH PROGRAM
of the
Section of Climatic and Physiographic Research

By C. W. Thornthwaite

Head of the Section of Climatic and Physiographic Research, Division of Research

AGRICULTURAL research is of three types: (1) experimental, (2) observational field and laboratory investigations, and (3) library and archive study. Although controlled experimentation is the most familiar type of methodology to agricultural research workers, the other types have contributed fundamental advances to agricultural knowledge. Modern soil science, for example, is a product of intelligent observation of the characteristics and distribution of soils, and methods for control of insect pests and crop diseases arise frequently from careful field observation. Historical library studies are important in all branches of agricultural research.

All three types of research are employed in the Research Division of the Soil Conservation Service. The work of the Section of Climatic and Physiographic Research, however, involves only the observational and library methods. It amplifies and supplements the results of controlled experimentation by providing an historical perspective and by supplying means for the extrapolation from experimental results beyond the limited areas within which the experiments are conducted.

Erosion History

Through research in the history of erosion it will be possible in a comparatively short time to assemble the results of past experience of individual farmers in erosion control and thereby determine the point at which experimentation should begin and indicate the direction for future research. By so doing some of the preliminary stages of experimentation might be eliminated and the final results checked against the experience of practical farmers. For example, it has been found that Bermuda grass, which was introduced into Oklahoma during the last decade of the nineteenth century, spread rapidly westward and its position as an erosion resisting plant seemed firmly established by 1908. Then came the cold dry years of 1909–10, during which Bermuda was killed out throughout the entire western half of the State. Recognition of this early farmer experience should make unnecessary further planting of Bermuda in the area where it proved to be unsuited. Detailed analysis of the climatic risks will make it possible to determine the limits of practical Bermuda culture not only in Oklahoma but also in the neighboring States. Beyond the limits thus established further experimentation on Bermuda grass for erosion control is useless unless hardier varieties can be developed.

Similarly, in all sections of our country erosion has followed closely upon settlement, and in each section the more progressive farmers recognized the evil and developed farm practices adapted to their individual erosion problems. In a recent publication entitled "Early Erosion Control Practices in Virginia", (U. S. D. A. Misc. Pub. No. 256, 1937), A. R. Hall has shown the large amount of valuable information for Virginia, the oldest of the States—information extending over a period of more than a century and a half.[1] As population moved westward, farmers at first practiced those control measures which had proved successful somewhere in the East. If these failed they were either discarded or modified to meet the new conditions, and new bodies of literature on the subject developed. For Oklahoma, the youngest agricultural State, local farm journals from 1890 to the present contain an invaluable source of information on erosion control.[2] Without doubt, similar material is available for all parts of the country. Experimentation is necessarily limited to selected stations and to the period of time covered by the work. The experience of farmers knows no such limits but includes all types of climatic conditions to which a region is subject and covers a wide range of physical and agricultural conditions and long periods of time. It extends beyond the limits of our own country. Types of climate are repeated in various parts of the world, and all sections of our country now suffering from erosion have their foreign counterpart. It is to these selected areas that we must look for new erosion-resisting crops, and much exploration in this field can be performed with little expense through library research.

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[1] A. R. Hall: The Problem of Soil Erosion in Ante-Bellum Virginia, p. 239 this issue.

[2] Angus McDonald: Erosion by Wind and Water in Oklahoma, p. 233, this issue.

THE RESEARCH PROGRAM
of the
Section of Climatic and Physiographic Research

In some foreign regions soil conditions have been maintained under cultivation for long periods of years. The means by which this has been accomplished has a direct bearing on the erosion-control problem in equivalent regions in the United States. Other regions have been abandoned because of erosion. Such is the case in the Ordos desert of North China, a region with a climate similar to that of the northern Great Plains. Extensive areas in North Africa and Assyria, which once produced abundant crops, have been converted into useless waste although the climate has remained unchanged. Similar changes are now occurring not only in this country but also in other new countries such as the Union of South Africa. What were the specific causes of such changes in the past and what conditions prevailed during the periods of transition? Such information is essential for the diagnosis of the stage of erosion here and for the development of long range plans for erosion control.

Physiography

For effective application of the knowledge of erosion control gained from past experience and current experimentation it is necessary to have a detailed and comprehensive understanding of the nature of various erosion processes, their effects on different soil types, and their varied manifestations under different conditions of land use. Erosion is a geologic or physiographic process caused by such natural forces as running water, wind, and frost. The importance of these forces varies according to geology, farm practices, climatic conditions, and other factors. Some soils are known to be particularly susceptible to sheet erosion and others to gullying. Under proper vegetative cover these soils may be completely protected from sheet erosion and gullying but may experience gravity movements of soil masses.

The nature of erosion is best determined by careful observation while it is taking place, for example in typical gullies or on washed fields during and after rains. It is essential that erosion processes be observed in action during rains and melting of snow, during freezing and thawing, during dry weather as well as wet, in short, under all possible conditions of climate. The effect of storms of various intensities differs according to land use, slope, underlying bed rock, soil type, and the particular soil horizon exposed to erosion, whether topsoil, subsoil, or parent material.

By field study in selected areas throughout the country the relations of erosion hazard to soil and rock types and to climatic conditions can be worked out and the regional pattern of erosion types can be determined.

A thorough understanding of the mode of development and life history of erosion forms should reduce the possibility of applying incorrect and unsatisfactory control methods, and should aid in the development of a technique of control by strategy rather than by force—working with the laws of nature rather than against them.[3] Only with a full knowledge of erosion processes and their relation to agriculture can an adequate program of control measures be devised.

Climate

Prerequisite to a general application of the knowledge of erosion processes in relation to soil, rock type, and agricultural practices is the detailed analysis of climate. Under given geologic conditions the erosion processes and effective means for controlling them will be similar throughout an entire climatic region. Thus the delimitation of climatic regions is necessary to the determination of effective limits of various erosion practices. Within a climatic region the hazard from water erosion, and consequently the designs for erosion-control structures, can be determined only through knowledge of the frequency of rains of specific intensities. The life-history analysis of rainstorms, now in progress, is yielding results of great importance concerning the behavior of storms of different types and the amount and intensity of rainfall which may be expected through the area across which the storm passes.[4] It has been found that there are two distinct types of rainstorms, each with characteristic size, shape, internal structure, and behavior patterns. The first type is of rather short duration (1 to 3 hours), covers from 700 to 900 square miles, and has centers

[3] C. F. Stewart Sharpe, "Brushing Out" the Banks of Streams, p. 221 this issue; D. Hoye Eargle, When is a Gully Stable? p. 225; and H. A. Ireland, Rotation of Gully Heads, p. 228.

[4] Leonard B. Corwin, Sampling the Weather at the Oklahoma Climatic Researc Center, p. 237, this issue.

of high rainfall intensity not infrequently up to rates of 5 inches an hour. The second type is of wide areal extent (sometimes as much as 400,000 square miles), of long duration, is gentle and continuous, and contributes a large amount of water. The first type of rainfall is most significant in the production of gully and sheet erosion as well as occasional local floods. The second type is significant in stimulating mass or gravity movements of soil, such as slumping and caving of gully sides and heads, and is invariably the cause of major floods.[5] Not infrequently in connection with the widespread, continuous type of rain, local areas will experience for short periods the high intensities characteristic of the first type. Of great significance is the determination in the field of the relation of the various erosion processes to rainfall types.

Wind erosion has been found to be less a function of velocity than of turbulence of the air. In turbulent air sometimes oval-shaped areas and sometimes channels of high velocity parallel to the wind direction develop on the surface. These channels or oval-shaped areas seem to explain why some fields may suffer greatly from wind erosion and adjoining fields may remain practically undamaged, even though soils and land use appear to be identical.

Frost action has a profound influence on a type of soil wastage provisionally called mulching. Alternate freeze and thaw, and the associated development of frost crystals or needles prepares the surface for sheet-wash and also directly causes considerable down-slope movement of the soil. A map of the United States showing the annual number of freeze and thaw periods tends to show the localization of this erosion process.[6]

Ecology

It is recognized that plants are ultimately both the most effective and the cheapest method of controlling erosion. At the same time, the plant cover affords the best means available for diagnosing the degree of erosion that has occurred or the stage of recovery. For example, in pastures a relative increase in certain species of plants is the first indication of overgrazing and should serve as a danger sign of subsequent erosion. Conversely, recovery and stabilization are heralded by gradual changes in the plant cover—changes which follow definite sequences under different soil and climatic conditions. Natural succession, for example, will differ at the mouth and head of a gully or on the A and B soil horizons. A thorough understanding of natural regeneration would in many places make possible a "short circuiting" of the normal processes of recovery. This principle has been successfully applied in other countries and the possibility of similar work in this country should be investigated.

Ecological research also includes the mapping of plant distribution and the delimitation of vegetation zones.[7] Because it reflects the interrelation of environmental factors, each vegetation zone will throughout its extent have essentially similar problems of erosion and erosion control. Consequently, such zonation will provide a basis for wider application of results obtained by experiment stations. Ecology is no longer a purely academic study but one of the most practical tools which can be applied in the rebuilding of eroded soils.

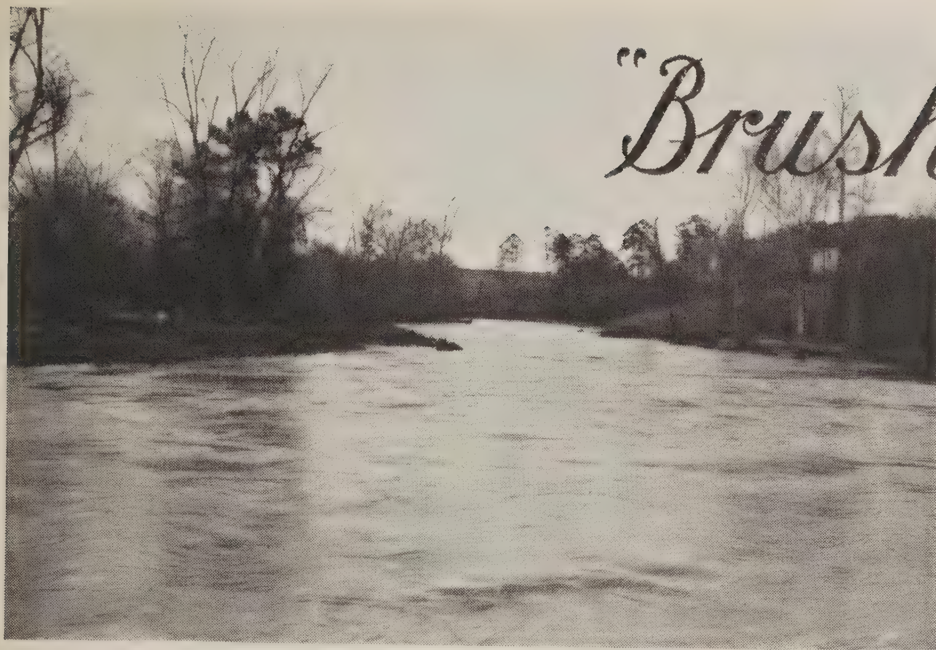
Although erosion on farm lands is induced by man and of a vastly accelerated type, nature has supplied means of control even for the most malignant forms. It remains for us to discover what nature has provided. Sometimes this involves the manipulation of the very forces which produced the erosion. When enough is known about the processes of gully formation the same water which caused the gully may be used to fill it up and stabilize it. Plants exist which will grow in virtually all types of environment. Even on the moving sand dunes of the North Pacific coast, Holland or European beach grass will thrive. It may be covered to depths of over 20 inches with blowing sand without killing. But as soon as the sand ceases to be mobile and begins to accumulate organic matter, Holland grass dies out and is succeeded by other species. This means that new species of plants must be discovered to meet each of the progressive stages of recovery not only on

(Continued on p. 236)

[5] B. Holzman and K. Clarke-Hafstad, Changes in Atmospheric Circulation Result in Floods, to appear in the May issue.

[6] H. Bates Brown, The Slope Factors in Soil Erosioin, p. 240, this issue.

[7] J. E. Englemann, Ecologic Relationships in the Oklahoma Climatic Research Center , p. 235, this issue.



"Brushing Out" the BANKS of STREAMS

By C. F. Stewart Sharpe[1]

Cutting of brush and trees from this segment has left a broad, clear flood channel which rushes the waters to the sea. North Tyger River, in flood, near crossing of Reidville-Spartanburg highway.

Same site as above during normal river stage, showing brushed-out flood channel and stumps of 20- to 30-year-old trees. Other trees cut nearby were over 60 years of age.

ALONG many of the creeks and smaller rivers of the country one may see today denuded banks bearing fresh scars of the ax, brush hook, and fire. Such are the signs of local "drainage" and "mosquito-control" projects on which vast sums are being expended to speed the removal of flood waters by clearing or "brushing out" the flood channels. The effects of such clearing are much more intricate than is generally realized and should be given full consideration before this work is carried further. Temporary improvement of flood conditions and sanitation may be attained in the areas treated but what of the people, lands, and cities downstream? How much will floods on the major rivers be increased by rushing the water down the tributaries? Trees cut along some of the streams cannot be replaced for 50 years and by that time what will erosion have done to the banks; how much sand will have been deposited on arable lands farther down the river? Potential destruction of valuable bottom lands makes this practice of brushing out demand investigation and observation by the Soil Conservation Service.

The behavior of a stream heavily loaded with sand and silt differs greatly from that of a flume carrying clear water and any upsetting of the delicate balance of the stream mechanism will be reflected by compensatory changes, often of a serious nature, both above and

[1] Assistant Soil Conservationist, Section of Climatic and Physiographic Research.

Sand flats on bottom lands along a creek which has been partially brushed out. During flood stage the entire flat at the right is inundated. Fair Forest Creek, 6½ miles southeast of Spartanburg, S. C.

Due to thick vegetation along the banks, flood waters on this small river move rapidly only in the normal channel. North Tyger River, in flood, 8 miles west of Spartanburg, S. C.

This valley, as described by the author, was formerly good farm land, but lateral swinging of the stream after the farmer cleared its banks of brush and trees, 36 years ago, made it suitable only for pasture and timber. Seven miles southeast of Spartanburg, S. C.

below. It is therefore important that projects involving alteration of natural conditions along a stream be considered throughly from all points of view and be planned with regard to their effect on the entire drainage instead of on a small artificial unit such as a county, township, or individual farm.

A Farmer's Experiment

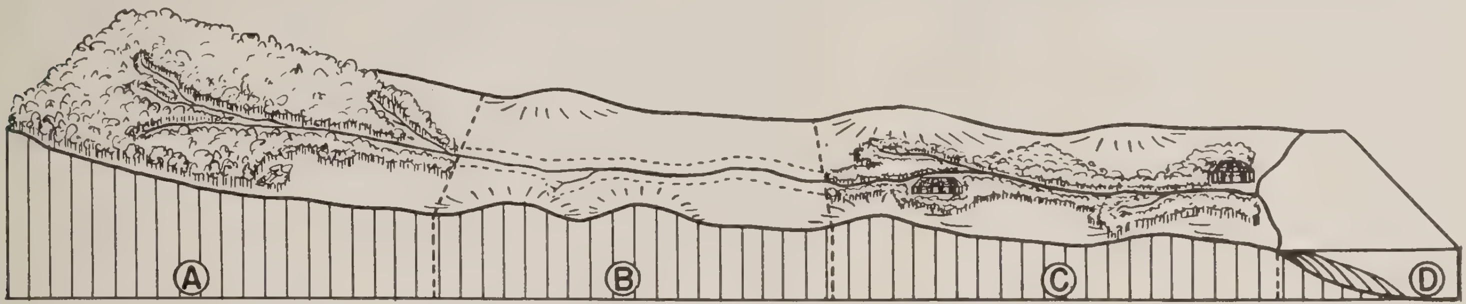
Some 36 years ago a farmer in the eastern part of Spartanburg County, S. C., decided that the land bordering a small stream flowing through his property would be improved if there were fewer trees along the banks to shade his crops and interfere with cultivation. The walls of the valley sloped in a gentle V-shaped profile and the stream flowed on a narrow valley flat, part of which was used for garden crops. The energetic farmer removed the brush and all but a few of the trees from along the stream but, unfortunately for him, cutting of the vegetation weakened the stream's banks. Caving and scouring followed and soon great bends and meanders were eating their way into his fields. Smooth slopes that once bordered the stream were cut away leaving cliffs 20 feet high and sand-covered flats.

Widening of the stream's flood-plain reduced the length of gullies and rills which drained the valley slopes and the general steepening of gradients resulted in deeper cutting of gullies into the hillside. The slopes of this little valley are now so dissected that they are suitable only for pasture and the excessive depth of the gullies makes the area hazardous for even that use. Accelerated stream erosion on this one farm has meant greater flooding and deposition of sand and silt on the lands farther down the valley. The owner fully realizes the mistake that was made and is quite ready to tell you, should you inquire, that brushing out the banks of his stream had been "a very poor idea!"

Many Local Projects

This story will be repeated on many other streams if local programs of brushing out continue. Most community drainage projects are on a somewhat larger scale and involve stretches miles in length—often the extent of the stream within a single county. A typical stream treated in this work is 20 to 40 feet wide, 3 to 10 feet deep, muddy, and flows in a rather broad valley with a narrow discontinuous flood plain. Weeds, shrubs, seedlings, and full-grown trees line its course. Cultivated fields and pasture lands lie along the margins of the flood plain and extend up the valley sides.

During high water the valley bottom is heavily inundated causing damage to crops, roads, bridges, and other valley-bottom structures. In order to reduce flood crests, by passing water on downstream more rapidly, bushes and trees are cut from the stream banks and from a belt 25 to 40 feet wide on both sides of the normal channel. The cuttings are burned or carried away leaving the ground practically bare. If



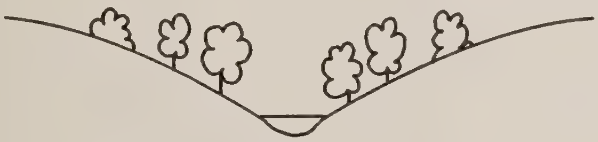
(A) Upstream segment.—Removal of vegetation along stream in segment (B) may cause accelerated downcutting of channel extending up into headwaters and tributaries, resulting in general steepening of slopes and increased rilling, sheet erosion, and soil creep.

(B) Brushed-out segment.—Removal of vegetation from stream banks allows more rapid drainage of flood waters, reducing crest heights and duration of floods but causing accelerated erosion of bottom lands due to increased lateral migration of stream associated with greater undercutting, slumping, and caving of banks; increased velocity during floods; increased scour and soil removal on bottom lands resulting in larger sand and silt load.

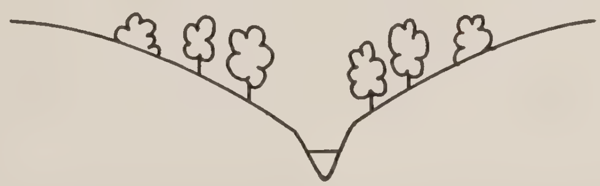
(C) Downstream segment.—More rapid receipt of flood waters from upstream produces higher crest stages, increased bank erosion of normal channel, and increased sanding of bottom lands due to retardation of currents by vegetation in flood channel.

(D) Mouth.—Increased sediment load from upstream causes greater deposition in deltas, bars, and spits, obstructing navigation and flood channels and gradually filling reservoirs and lakes.

A.

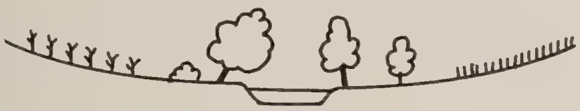


Natural condition.



Increased downcutting of channel may result from brushing out of segment (B).

B.



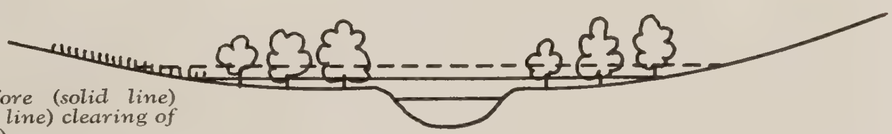
Natural condition.

Flood channel cleared by cutting out of brush.

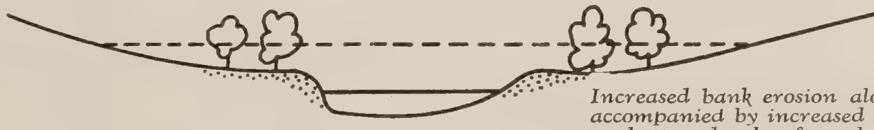
Stream channel widened by bank erosion and made more shallow by silting and sanding.

Bottom lands badly eroded by lateral migration of normal stream channel which is now cutting into valley side.

C.

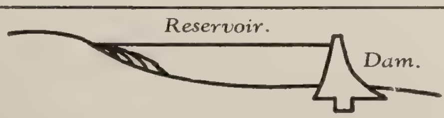


Relative flood crests before (solid line) clearing and after (dotted line) clearing of segment (B).

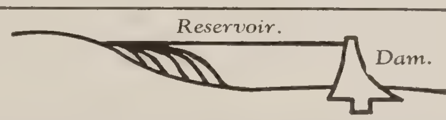


Increased bank erosion along normal stream channel accompanied by increased deposition of sand and silt on bottom lands after clearing out of segment (B). Sand is deposited closest to stream and nearest to segment (B); silt farther downstream and away from normal channel.

D.



1. Before clearing of segment (B)—small delta, large water-storage capacity.



2. After clearing of segment (B)—larger delta, water-storage space filling more rapidly by increased sand and silt deposition.

the roots on the cleared area decay before additional growths have time to develop, marked changes in the channel are likely to occur. In any case the removal of obstructing vegetation from the flood channel will subject it to greater scour and correlated changes on other parts of the drainage are likely to follow. The general result will be an increase in the activity of the soil-erosion processes.

Increased Channel Erosion

In the cleared, or brushed-out, segment of the valley the absence of vegetative obstructions allows more rapid drainage of flood waters with resulting lower flood crests and shorter duration of high water. The advocates of "brushing out" claim that there would be less opportunity for breeding of mosquitoes and other pests, so malaria would be less common. In the long run, however, the effect would be negligible. In the absence of systematic patrol and oiling the numerous stagnant pools which would remain in the flood plain would themselves serve as breeding grounds for mosquitoes. In addition, clearing out of soil-binding vegetation facilitates scouring, slumping, and caving, and the stream tends to migrate sideward endangering large areas of bottom lands. Higher velocity due to freer movement of floods enables the waters to carry a greater sediment load, providing more and better tools for abrasion. Due to brushing out of the flood channel, there is usually less concentration of flood scour in the normal stream bed. Bank erosion tends to increase the width of the normal channel, thereby allowing it to carry the same flow with less depth. The resulting aggradation in the channel leaves only shallow banks which are easily overtopped by flood waters. More frequent flooding of bottom lands follows.

The more rapid drainage of flood waters from the brushed-out portion of the stream may in other cases cause increased scour and deepening of the flood channel. If this deepening is propagated upstream and into the tributaries above, the brushed-out area slopes will be steepened and increased rilling, sheet erosion, and soil creep will result.

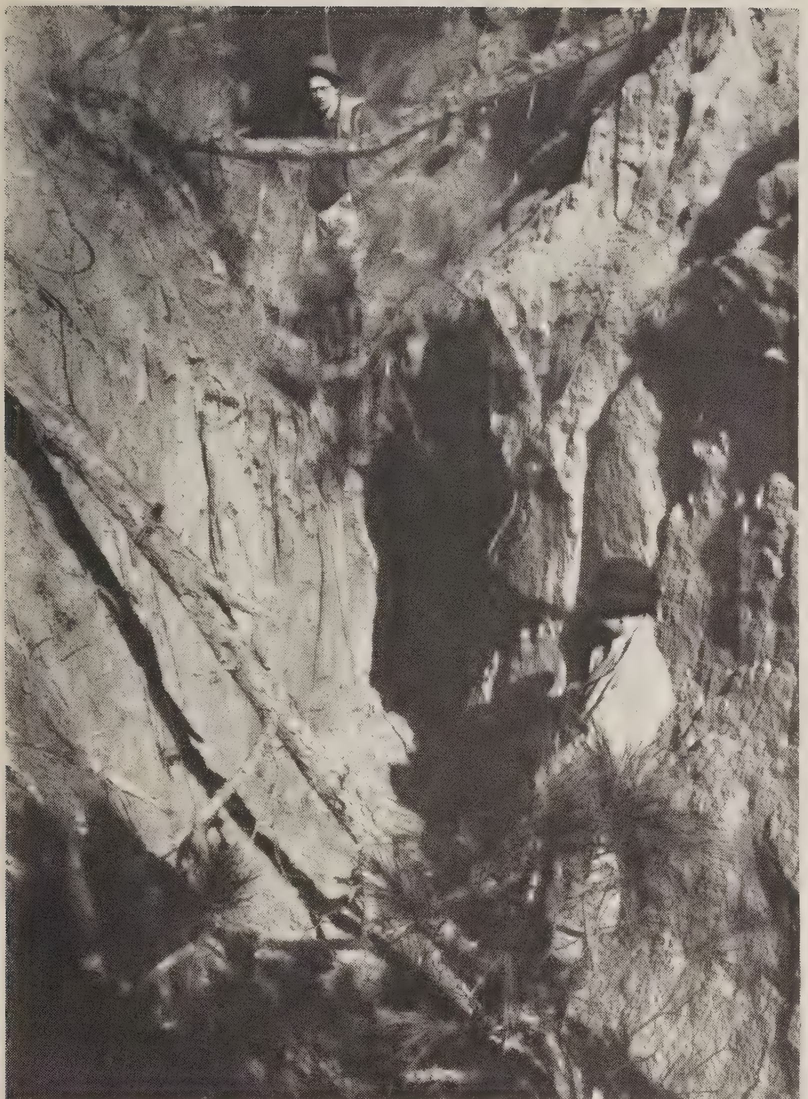
Downstream from the brushed-out area flood conditions will be worse than before. Flood waters which have been speeded through the cleared stretch upstream are here retarded by vegetation on the stream banks and bottom lands, causing floods to build up more rapidly and reach higher crests. Increased head tends toward increased velocity where flood currents are concentrated along the normal stream channel and erosion of banks is accelerated. Outside of the normal channel, however, the flood waters move but slowly. Most of their transporting power is lost and much of the silt and sand carried down from the brushed-out area is dropped. Silt deposition may not be detrimental to agriculture, but sand accumulation is responsible for the destruction of extensive areas of valuable bottom land.

At the mouth of the stream its flood waters and the remainder of its transported load are poured into a larger river or body of standing water. Here again the effects of the brushing out are felt. If the flood crests of the tributaries are synchronized a major flood is produced on the trunk stream. If, on the other hand, only one tributary is in flood its transported load tends to be deposited at the juncture with the more sluggish main river. The sediment reduces the flood capacity of the major stream, obstructs navigation channels, and makes the water less fit for industrial or sanitary uses. In lakes and reservoirs it accelerates delta building and general silting, which may seriously curtail or eliminate storage capacity for power or water-supply purposes, as has been shown by the Section of Hydrodynamic Research of the Soil Conservation Service.

Careful Planning Needed

These various effects indicate how human interference with the normal regimen of a river may produce many unlooked-for and serious results. (See "Little Waters", p. 27 and 39.) Local alteration of a river channel affects areas far removed from the locality in which the change is made. For this reason it is highly unwise that any program for the control of a through-flowing river should be restricted to a single county or other small arbitrary unit. Plans should include the entire watershed and should consider also the major drainage to which the project is tributary. Only by the most careful consideration of competently trained experts can the full consequences of such river-control measures be foreseen. There have been innumerable cases of streams getting out of hand due to ill-advised control measures with resulting serious losses to agricultural land. It is therefore of vital interest to the Soil Conservation Service to forestall such expensive blunders.

NOTE.—*Climatic maps in this issue were compiled and drafted by J. C. Owen, assistant soil conservationist, Division of Climatic and Physiographic Research.*



A "knick" about 9 feet high, advancing headward into a partially stabilized gully in Fairfield County, S. C.

When is a GULLY STABLE

by D. Hoye Eargle[1]

IN MANY of the older agricultural regions of eastern United States there are hillsides, now covered with a thick second growth of forest vegetation, which were once riddled with active gullies. While such gullies bear witness of destructive agricultural practices of the past, their activity has ceased and they are commonly regarded as stable. Without the interference of man, they might remain stable but, if the natural drainage is altered or if the run-off of adjacent fields is increased by the removal of the absorbent topsoil, the activity may be resumed and a new cycle of erosion introduced.

Gullying Resumed

Many of the gullies, once healed, have resumed their latent activity and are again cutting both headwards and downwards. The vegetation is being removed and the slope of the gully walls is becoming steeper. This is especially characteristic in regions where resistant bed rock does not immediately underlie the surface. Those who would heal gullies artificially—by building check dams or by sloping the gully walls and then planting to vegetation—should first understand those forces which initiate renewed gully cutting.

About 1802 Playfair of the University of Edinburgh stated the law that all streams join at accordant levels. The corollary of this principle is also true: when the trunk stream becomes lowered all tributary streams tend to adjust themselves to that level. This principle applies not only to major drainage systems but also to the more minute features of the landscape, whether they be gully systems, terrace drains, or rills in sheetwashed fields.

The Knickpoint

Detailed mapping and continued observations of gullies in Spartanburg County, S. C., have shown that Playfair's law and its corollary are amply illustrated by the downward cutting and headward ad-

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vancement of gullies and by the initiation of new cycles of erosion when the levels of the master streams are lowered. As the lowering proceeds, the tributaries cut faster to keep pace with it. A steepening of the gradient near the mouth of the gully results. This migrates upstream as either a rapid or a fall. Such a step moving up a stream profile is known in the geological literature as a "knick" or "knickpoint."

If layers of unequal resistance to erosion exist in the soil or parent material, or if a mat of roots covers the channel of the gully, the "knick" is usually vertical or overhanging. In these cases the more resistant soil, rock, or vegetable matter holds up the top of the step and a cave may develop in the less resistant material beneath. The headward advancement of this step, as erosion continues, is accomplished chiefly by repeated breaking off of the lip and the caving in of the sod and trees when the old gully floor is undermined. If the material is homogeneous, or if little vegetation is present to toughen the gully floor, the "knick" is likely to be less abrupt or even a series of small steps.

How Base Level Is Lowered

The downcutting of a master stream or of one of the tributaries may be caused by an increase in volume of water flowing through it. This may be due to the rearrangment of the natural drainage by terracing or road drains, the breaking over of former terraces, or the removal of the absorbent topsoil from adjacent agricultural lands. If an "erosion pavement" [2] has developed as a result of sheetwash on lands with a tight or stony subsoil, the run-off is particularly rapid.

The lowering of the base level may also be caused by forces originating downstream. The clearing of valley lands below the gully system increases abrasion by the stream. It may then cut through a resistant channel floor to undermine it by sapping and caving of the weaker material beneath. Field observations indicate that this is one of the most frequent causes of renewed gully cutting.[3]

The Knick Advances

Two conspicuous illustrations of the conditions accompanying the destruction of all the stabilized features of gullies have been studied and mapped in Spartanburg County, S. C. In a gully on the farm of Fletcher Layton, 11 miles south of Spartanburg, a "knick" or step, now about 4 feet high, is advancing headward rapidly and in the process is clearing out trees as much as 33 years old and 10 inches in diameter. During the heavy rains of October 16 and 17, 1936, the "knick" advanced about 10 feet headward. In the area below, the average width increased from 15 to about 25 feet, causing the banks of the gully to cave in and uprooting many trees. The run-off from each successive storm drains through the gully, sweeps out the material which has caved into it, and advances the "knick" farther into the stabilized area.

Available evidence indicates that the cause of the rapid deepening of this gully is an increased flow of water into one tributary of the gully system. On the catchment basin of that tributary almost all of the topsoil has been removed, and during rains the water flows over a resistant clayey subsoil. In addition, several terraces have broken, which has increased the drainage area considerably. The increased run-off of the tributary has deepened the main gully below the junction and has produced a sharp "knick" which is migrating up the main gully channel.

Additional Water Accelerates Cutting

The second example occurs on a farm 3 miles southeast of Spartanburg. An extensive gully system in this neighborhood remained stable from about 1880 until some 15 years ago. Shortly thereafter more water was added to one of the tributary channels through a highway ditch and a terrace outlet. This channel has now cut downward 10 or 12 feet into the friable, parent soil-material and has caused "knicks" to progress up all of the other tributaries. Accelerated cutting has so deepened the active tributary channel that it has now become the master stream and the original master stream is but its tributary, flowing at a level about 7 feet above the other and emptying into it over a series of waterfalls and cascades.

Watershed Must Be Protected

It is evident that the "stability" of a gully may be described more accurately as "dormancy." To prevent rejuvenation or the renewal of excessive cutting, the watershed of the gully must be protected. This may be accomplished by cultivation practices designed to prevent excessive run-off, by revegetation, or by building up the organic content of the soil. The valley below must also be protected in order to prevent the stream from lowering its present base level. An increase in the water supply in any part of the drainage system beyond its normal capacity is therefore a potential source of danger.

(Concluded on opposite page)

[2] See W. C. Lowdermilk, Agricultural Land-Use and Flood Control, occas. publications of the A. A. A. S., no. 3, October 1936, fig. 14, p. 26.

[3] See C.F.S. Sharpe, "Brushing-out" the Banks of Streams, p. 221

A gully 3 miles southeast of Spartanburg, S. C., recently redeepened about 12 feet below its former stabilized level. The dead tree is a remnant of the thick growth which formerly covered the gully bottoms.

"Erosion pavement" increases run-off and accelerates the down-cutting of streams below. A large, deep gully has formed below this shallow one because of increased run-off.

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Therefore, in answer to the question "When is a gully stable?", one may say that a gully is stable, not when the walls and head have ceased advancing, nor when the channel of the gully has ceased cutting downward and is filled with growing vegetation, but only when all precautions have been taken to prevent renewed cutting and the consequent introduction of a new cycle of erosion.

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The pictures immediately above and below show how the clearing of vegetation in valley lands may cause serious stream erosion, causing "knicks" to progress up older gullies, as on this farm 8 miles south of Spartanburg, S. C.

Tree roots retard the advance of a "knick" in a gully bottom by forming a protecting mat over the friable soil material.

ROTATION OF GULLY HEADS

A New Conservation Practice for Gully Control [1]

By H. A. Ireland [2]

THE CHIEF objective in gully prevention and control is to conduct surface water to lower levels in such a manner that soil is not removed. Ideally this would involve the prevention of any concentration of water on any part of the surface. Practically, water concentration cannot be prevented where terraces and artificial drainage channels are used in erosion control. In certain situations, where gullies already exist, they may be stabilized by directing the surface run-off successively into several different heads, creating new heads if they are not already available.

A Simple Control Measure

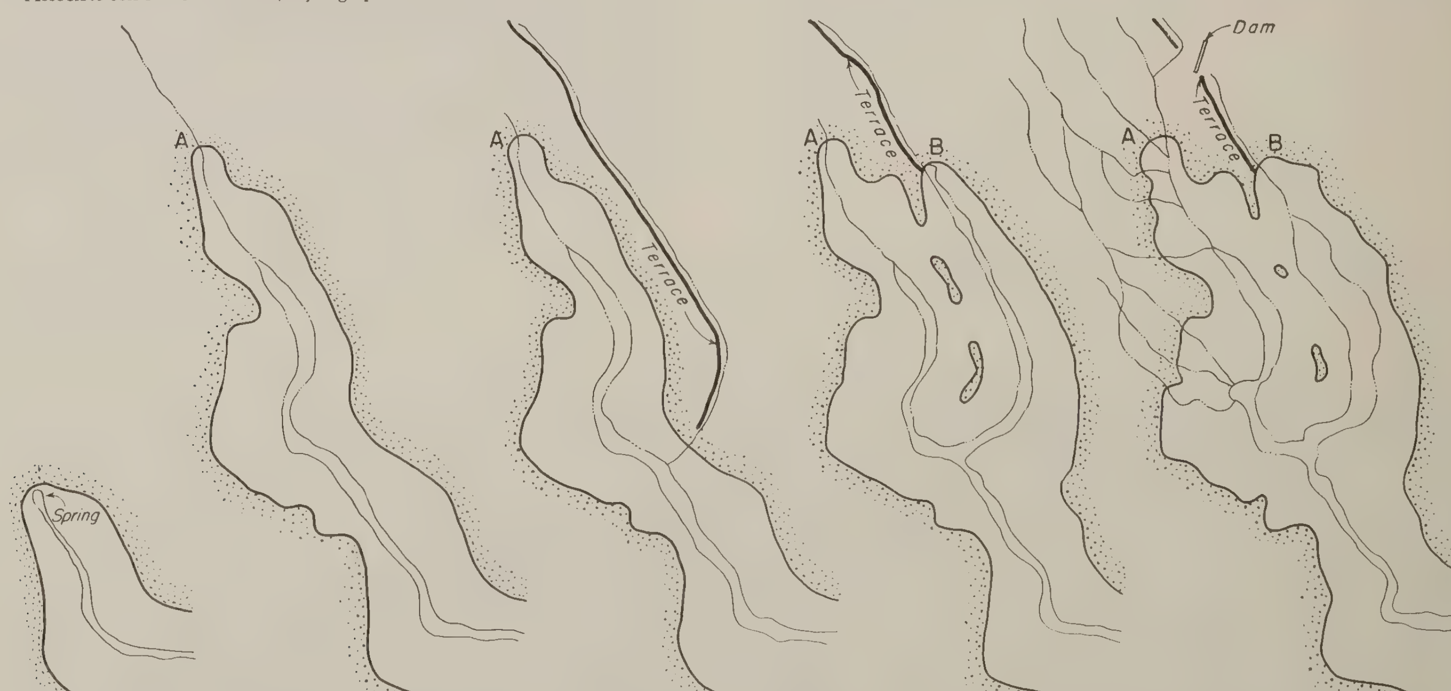
THE gully on the farm of R. H. Barry near Moore, Spartanburg County, S. C., is an excellent illustration of the way in which an intelligent farmer has successfully tackled the problem of erosion through "rotation of gully heads." A wooded valley in Appling soil, headed by a spring, was converted into a headward-cutting gully (designated as "Head A") as a result of erosion induced by cultivation. By 1917 gullying had become serious and the owner diverted the water away from the cutting head by means of a terrace to enter the main channel about 150 feet farther down. The new channel outlet was unprotected and the water started a new gully head (Head B) which migrated headward along the terrace channel. The older gully was set out to briars, climbing rose, and honeysuckle, and rubbish was thrown into the head. Assisted by caving of bermuda sod, the walls and head began to stabilize themselves.

In 1933 Head B had been cut to about the same length as Head A and was considered a hazard. In the interval of 16 years Head A had become so well stabilized that the farmer decided to plow out one side of the terrace leading to Head B, block the terrace drain, and divert the water back into Head A. Head B is now beginning to be stabilized by saplings, briars, and rose cuttings, and the walls are caving so that they will eventually form a slope on which vegetation can be established. Head A is showing slight effects from the new irritation but, by the time it gets to a hazardous stage, it is expected that Head B will be sufficiently stable to receive again the water which may be turned back into it.

In addition to the protection afforded by the rotation of heads, most of the fields draining into the gully are well protected by lespedeza alternated in broad strips with wheat. Where cotton is grown, an inter-row of

[1] The thesis presented in this paper was developed in conjunction with Dr. Maurice Donnelly in November 1936.

[2] Associate soil conservationist (Physiographic Research).



Old Valley About 1895 — Cutting Of Head "A" Prior To 1917 — Diversion Of Water 1917 — Cutting Of Head "B" Prior To 1933 — Diversion Of Water Back To Head "A" 1933

Alternate gully heads on a South Carolina farm. Head "A" at left is well vegetated and now receives the run-off from the farm, while head "B" at right is given time to grow protective vines and grasses. The gully head is surrounded by a pasture of Bermuda grass with cotton beyond the fence at the left and wheat after lespedeza in the field beyond the house.

oats is used as a winter cover. The whole farm has gentle slopes, the maximum not over 10 percent except in the old timbered valley through which the gully drains. Immediately adjacent to the gully is a Bermuda grass pasture, extending 100 to 200 feet back from the rim, which is quite effective in reducing and distributing the run-off from the cultivated fields.

Of Wide Application

A PROPOSED procedure for the application of the principle of rotation of gully heads to other areas might be as follows: If a multiple-head gully is surrounded by cultivated fields with terraces draining into the gully, all of the water from the major gully heads might be diverted into one or two of the less active or partially stabilized heads, now receiving very little run-off. Appropriate vegetation could then be started in the heads from which the water had been diverted. When the new drainage heads begin to show signs of excessive cutting the water could be returned to the original heads, which in the meantime had become sufficiently well stabilized to handle the run-off. Temporary structures might be employed at first in order to allow some of the treated heads to gain a good cover of vegetation. Later, when the vegetation in any of the drainage heads begins to fail, the water could be diverted to another head where the vegetation was well established. A strip of land adjacent to the gully should be planted to bermuda grass, lespedeza, or other suitable cover to disperse the run-off as much as possible before it entered the gully. A procedure such as this would permit the utilization of the principle of rotation of heads as a regular part of the farm management.

It is conceivable that the water might be diverted from all heads and drained over some intermediate point on the rim. This would develop a new head but as the area between tributary gullies is not likely to be utilized agriculturally, the use of the new head would allow all of those formerly active to become vegetated until one or more could carry the surplus water without serious erosion. If such a new head on the rim were not allowed to work back farther than those being treated, no additional land would need to be abandoned to the gully area. And after the initial period of revegetation it is probable that no new gully heads would be required. If no additional agricultural land were damaged by the establishing of

(Continued on p. 244)

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HIGHWAY M

HIGHWAY MENACE has only one connotation to the average man, familiar as he is with the accidents and fatalities incident to traffic. But the term could legitimately be applied to the serious and widespread loss of soil which has been incident to highway construction and maintenance in many parts of the United States. Because the condition is not universal, while improper management of farmlands is more nearly so, the loss and destruction of agricultural soil through erosion is, as a rule, tacitly if not openly laid to the farm operator. Seldom are the authorities in charge of highway operations called to the bar of public opinion in this matter, particularly since there has been a marked improvement in the design of great arterial highways during the past decade.

ACTUALLY these arteries, in the average county, form but a small fraction of the total highway system. Assuming a county to be 40 miles square, crossed by two arterial routes, these will total 80 to 110 miles in length, as against about 3,000 miles of so-called "county laterals"; in other words a linear ratio of about 1 to 30 or 40. The former enjoy the supervision of well-organized Federal and State highway departments, often working together; the latter are dependent upon the attention they receive from county or township authorities, aided by county engineers who are often burdened with many other duties and who may not have the special training required for modern road maintenance.

FREQUENTLY these county laterals are doctored by local citizens working out their poll tax, often using powerful machinery, and commonly left pretty much to their own judgment.

IN many parts of the United States, particularly where there is an abundance of natural vegetation and little topographic relief, the consequences may not

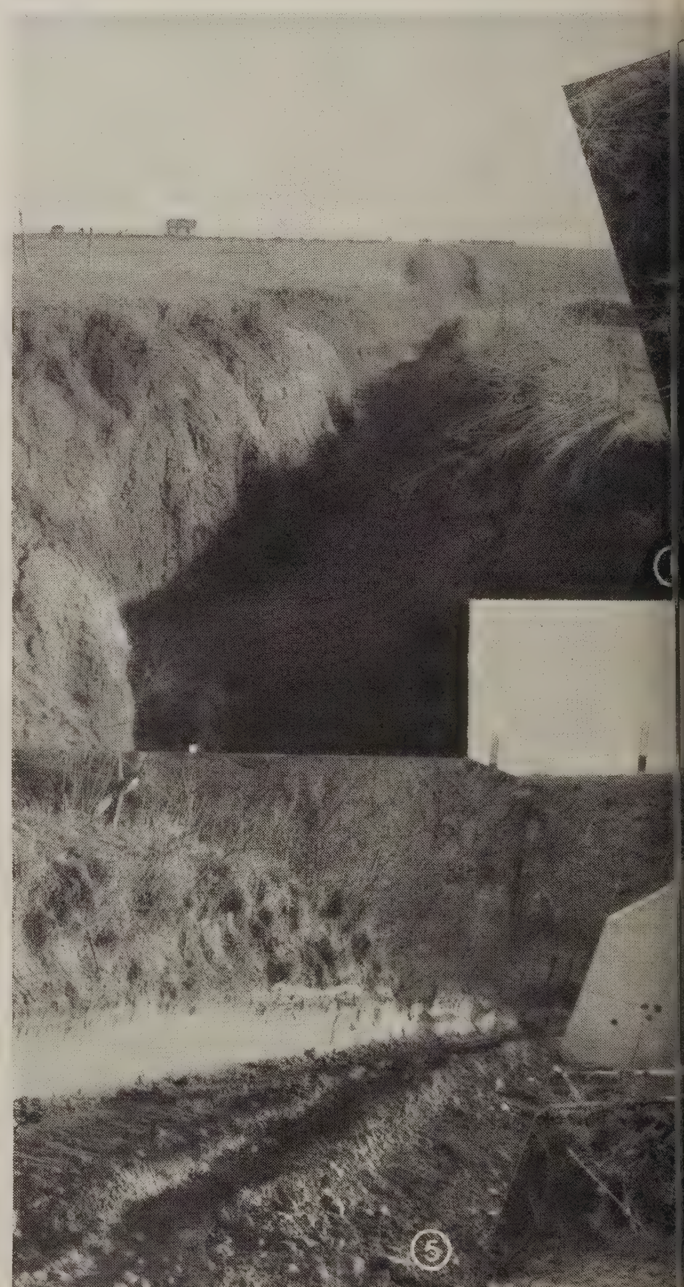
(Continued on p.232.)

NOTE.—This article was prepared from materials supplied by Charles C. Smith and O. W. Hunn while temporarily employed by the Section of Climatic and Physiographic Research.

1. Sharp ditches tend to cut laterally and vertic y.

2. Sharp V-shaped ditches are the ideal of the ave ge grading crew.

6. Effects of man



ENACE

by
PAUL·B·SEARS
Collaborator of the Soil Conservation Service. Professor of Botany, University of Oklahoma.

3. In the loess areas of Mississippi, highways have dropped in some cases as much as 30 feet below the surrounding terrain.

4. Ten gullies to the mile is the average in one county on its lateral roads.

5. In one county of Oklahoma the average county lateral has sunk 2 feet since settlement.

ts suggest placer mining.

7. Broad, flat ditches covered with vegetation prevent cutting.

be serious. In northern Indiana and Ohio, for example, there are many roads which have been in continuous use for over a century without suffering much change of level or giving rise to serious erosion. The other extreme is to be found in the loess areas of Mississippi where highways have dropped in some cases as much as 30 feet below the surrounding terrain, the walls, because of the curious vertical structure of loess, often remaining nearly vertical, except where slumping and gullying have developed, as they frequently do.

IN one county of Oklahoma, for example, O. W. Hunn and Charles C. Smith have recently found that in the 40 years since settlement, the average county lateral has dropped about 2 feet, and is responsible for about 10 gullies to the mile. Similar conditions exist in adjoining counties. The tonnage of soil which has been thus lost is appalling.

ON the other hand, in comparable areas of Texas, a much older State, the damage may be considerably less. According to Hunn, this may be due to the fact that the roadways of Texas are based upon early trails, and hence upon topography. However, there are many examples of excellent highway drainage practices being employed in the State. The Oklahoma roads, on the other hand, are based upon the rectangular system of congressional townships and sections inaugurated in 1786, and subsequently employed, so far as possible, wherever new United States lands were opened to settlement.

THE development of this grid of section line roads, regardless of the course of topography, has had the effect of superposing upon the original drainage system an entirely new pattern. The removal of vegetation is in itself sufficient to establish a pathway for water; and where rainfall is inadequate to restore a vegetative cover promptly it is the more likely to be severe when it does occur. Moreover, the higher temperatures of the Southern States, favoring, as they seem to, the production of colloidal soil material through chemical weathering, are in themselves probably conducive to rapid erosion even where rainfall is favorable to quick revegetation. Thus, the contributory part played by roads in gully erosion is to be expected in the grassland States and in the Southern States generally, except where, as in parts of Texas, it has been checked by other factors.

IT must be noted, however, that under some conditions any kind of roadway, whether based upon old trails or a grid system, is a potential erosion menace. This is true in the southern Piedmont area, whose highways originated without reference to the congressional township plan.

IN practice, the first effect of altered drainage thrown into a new road is to roughen it by developing channels. This calls for reworking of the surface, of course. But with the powerful grading machinery now available, effort is not confined to smoothing the furrowed surface. Sharp ditches are cut at the sides, on the theory that they will get water off the surface as soon as possible. But any physiographer recognized a V-trench as a youthful drainage line, automatically inviting rapid cutting, both vertical and lateral. This in fact, is precisely what occurs in the majority of cases. Field observations made by Hunn and Smith, and by others as well indicate that where the ditches are relatively flat, and particularly where their vegetative cover is not disturbed, such cutting is reduced to a minimum.

QUITE as serious in its consequences, although less widespread, is the improper placement and design of culverts. Frequently these concentrate the flow and give it a drop which causes rapid cutting. In the worst cases the effect suggestss placer mining.

IT is not to be inferred from the preceding paragraphs that the problem is merely one of ordinary engineering technique. In the last analysis it is part of the broad general problem of adapting the landscape to a modern civilization. Fundamentally this is an ecological problem, and a very difficult, not to say challenging one. Needs and relative values must be determined, and a working balance established between man and his environment so that the present destruction of capital wealth can be stopped. In detail the problem is also one of ecology. The creation and maintenance of a suitable plant cover which will minimize erosion and yet not impede necessary drainage calls for as intelligent understanding of vegetation and plant succession.

RECOMMENDATIONS for remedy will appear in forthcoming reports. In the meantime it has been found easy to interest chambers of commerce in

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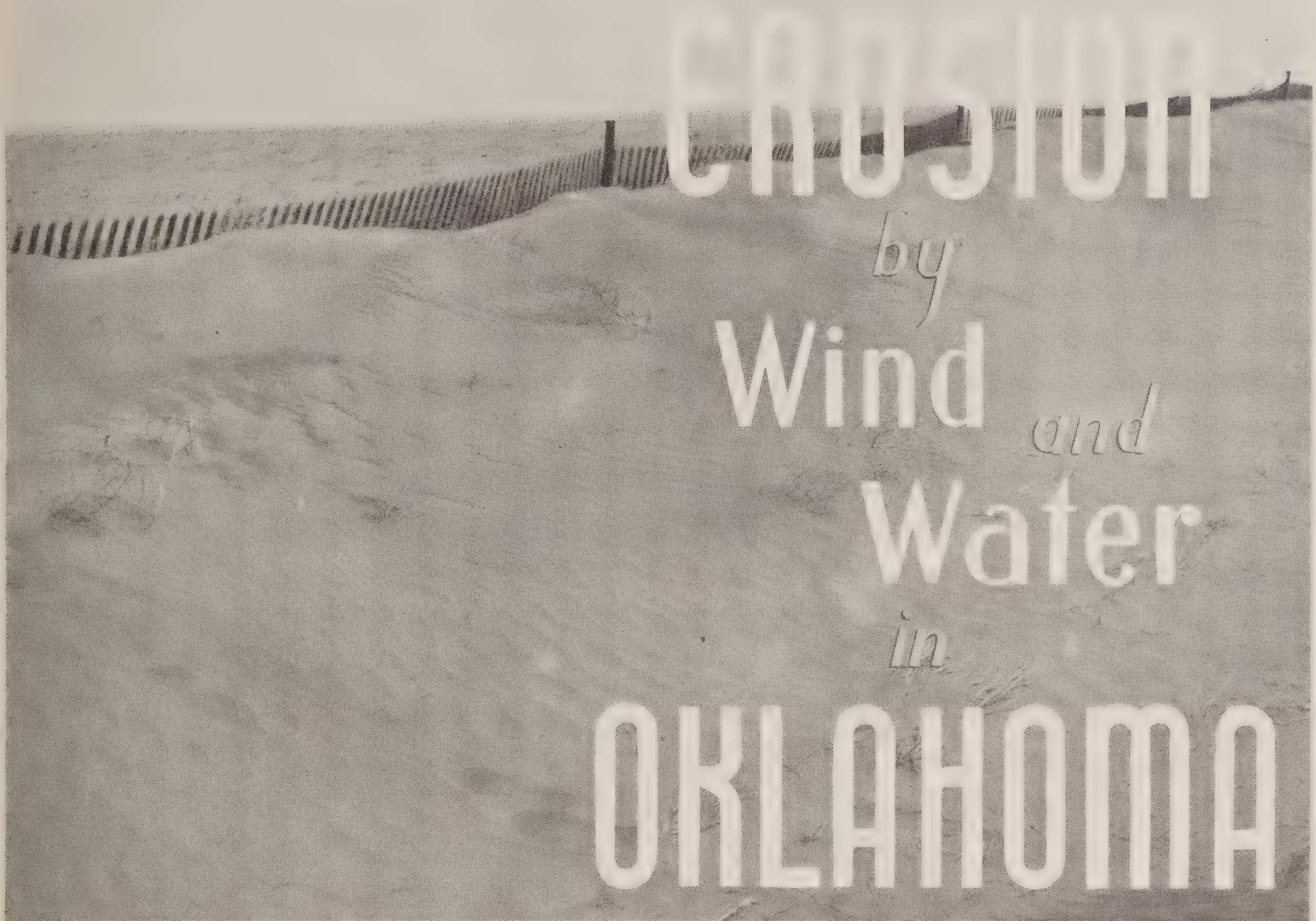
EROSION by Wind and Water in OKLAHOMA



Gradually local drifting merged into the greater problem of dust and sand storms.

BY

ANGUS

MC DONALD [1]

THE RUSH of settlers to Oklahoma, which continued from the first opening in 1889 to the last in 1906, resulted in a rapid destruction of the native vegetation. Under natural conditions eastern Oklahoma was predominantly forest, while the west was grassland. Between these was a transition zone in which the boundaries of the two are shifting and ill-defined. Almost immediately after the removal of the vegetation, erosion in Oklahoma became critical. The gradual pecking by drops of water upon the cultivated soil, the local shifting of the sands by the wind, passed unnoticed in the beginning. Yet each segment of land presented in miniature a picture of the entire area at a later date and a warning of what may be expected after a period of exploitation.

Water erosion, in particular, escaped notice. The land was gradually whittled away; the changes, imperceptible at first, were discovered too late or ignored as unimportant. Even when erosion had reached a point where it could no longer be ignored, it did not receive the consideration that it merited. Land was still plentiful and when the soil from a hillside was washed away, the farmer cleared more land in the bottom or upland and abandoned his first field.

[1] Formerly Assistant Soil Conservationist (Erosion History), Section of Climatic and Physiographic Research.

Erosion appeared first in those areas which were put into cultivation earliest. Old Oklahoma was opened in 1889 and the Cherokee Outlet in 1893. Large parts of this area, especially in the east, were planted in wheat and corn. These regions were naturally the most attractive to the immigrants from humid lands, especially to those who had experienced disaster in the semiarid sections of Kansas and other States during the drought of the early nineties.

The Panhandle and western tier of counties were shielded from exploitation for a few years because of isolation and aridity. The rancher clung on as long as possible and, although dominated entirely by self-interest, convinced many that extreme western Oklahoma was not suitable to farming. But the fate of the extreme west was only delayed. As the more desirable portions were occupied, the homesteader pushed into the remaining territory. The settlement of the southwest (with the exception of Greer County, which had been settled earlier as a part of Texas) began with its opening in 1901. The years which remained before statehood witnessed the destruction of the free range. The rancher had come sharply into conflict with the farmer as each new area was opened. The result was always victory for the farmer and finally in 1906 the "Big Pasture" was opened and the range was no more. Not only were the newly plowed lands susceptible to erosion, but as the range became successively smaller, and overgrazing resulted.

Soil Blowing Begins

Although farms in the sandy areas suffered from water erosion at certain periods of the year due to the spasmodic rainfall, the problem of wind erosion with its more spectacular aspects, was readily noticed by those who occupied the land. Drifting of the soil, especially when it destroyed young plants, could not be ignored, and the unpleasant effects of sand and dust, rendered the farmers more alert to the problem.

Farmers in the west had long been familiar with dust storms by the time they first made their appearance in Oklahoma. Reference to sand and dust storms during unusually dry years are numerous in the files of farm papers. They were not usually localized and it is probable that the storms of Oklahoma during the early nineties had their inception in Kansas and farther north since they did not always coincide with unusually dry local conditions.

In its early stages sand drifting is quite distinct from sandstorms, although both are caused by lack of moisture, and the remedy for both lies in proper use of the soil. At first drifting was purely local and in consequence farmers at first tried to solve the problem locally. Their methods were varied, often complex, and based solely upon individual experience. But as the drifting became more widespread the problem became too large for individual concern. A farmer who had effectively practiced methods for controlling blowing found his crops buried in a sea of dust from neighboring fields. Almost imperceptibly local drifting merged into the greater problem of dust and sand storms.

Trial and Error

The erosion control practices employed by the more progressive farmers were based on their own experience and since most of this experience had been acquired in the more humid sections of the country, a period of trial and error preceded the development of control practices adapted to the new environment encounterd in Oklahoma. The first big problem of the farmer was to insure adequate moisture for crop growth. The solution or partial solution of this problem led to the westward extension of agriculture. Practices such as dry farming, introduced to insure adequate moisture for crops, increased the erosion by wind and water and new techniques were developed to combat the growing problem. In some areas it was necessary to abandon deep fall and winter plowing to check the blowing. In other areas listing supplanted plowing and on very "blowy" land the disk entirely replaced the lister and the turning plow. The harrow, which resulted in disaster in some places, proved beneficial under other circumstances. As early as 1904 it was recommended that the plains farmer turn back to grass, and in 1902 John Fields began his long crusade for Bermuda. Other cover crops were recommended and tested by individual farmers, and experiments were made on the restoration of humus to the soil.

Farmers who thought that they had found the solution to the erosion problem recorded their successes in the local farm journals. Others who adopted these practices wrote telling of their successes or failures. In this way erosion control measures were tested under a variety of environmental conditions and over a long period of years. Results proved that there was no universal method of meeting the problem; that the practices employed must be adapted to different climatic conditions and different soil types. This involves not only further controlled experimentation but also the determination of regional types of erosion processes.

In 1902 John Fields began his long crusade for the planting of Bermuda grass to control erosion.

In spite of the intelligent efforts of individual farmers erosion by wind and water swept over the State of Oklahoma. For the work of one progressive farmer there were careless methods of farming by the hundreds. The solutions of individual cases of erosion lose much of their significance when later the enterprising farmer is overwhelmed by erosion caused by his neighbor's neglect. The frequency of such occurrences indicates that soil erosion is a community problem which can be solved only by a land-use and land-conservation program which includes all of the farms rather than a few. But without the preliminary experiments of individual farmers the development of an adequate program of land-use could never be formulated.

ECOLOGICAL RELATIONSHIPS IN THE OKLAHOMA CLIMATIC RESEARCH CENTER

By J. E. Engleman [1]

THERE are perhaps few areas of comparable size more suitable for observing the reactions of plant life to climate, topography, and soils, than this which is included in the Kingfisher Climatic Project. Beginning with eastern Logan County, it extends 84 miles westward through Kingfisher and Blaine Counties and shows a range in elevation from less than 900 feet in eastern Logan County to more than 1,800 feet in western Blaine County. This increase in elevation is rather gradual until the escarpment known as the Gypsum Hills is reached. It rises 200 to 300 feet above the plains of southwestern Kingfisher and eastern Blaine Counties and roughly parallels the course of the North Canadian River. Another less abrupt rise southwest of the North Canadian River in western Blaine County results in the maximum elevation of the area. Three sand-choked rivers with broad, irregular belts of aeolian material along their north slopes flow in a generally southeast direction, the Cimarron River across Kingfisher and Logan Counties and the North

[1] Junior soil conservationist (Climatic Research), Section of Climatic and Physiographic Research; Oklahoma. Climatic Research Center.

and South Canadian Rivers across Blaine County. Average annual rainfall varies from about 25 inches on the west to about 35 inches on the eastern boundary.

The southeast third of Logan County lies within the Central Cross Timbers, a belt of Black Jack Oak (*Quercus marilandica Muench.*) and Post Oak (*Q. stellata Wang.*) which covers a large part of the sandstone hill region of central Oklahoma. The presence of ferns and other plants adapted to shade and abundant moisture lends an appearance of lushness not found over the rest of the area. Fingers of Black Jack Oak follow the aeolian belts of the rivers mentioned above from these Central Cross Timbers to quite a considerable distance northwest of the three counties, but the existence of woodland west of Logan County is probably made possible only by the relatively deep deposits of loose material. Where more clayey soils are found, only a few miles from the woodland, mixed prairie occurs; in Blaine County, although Black Jack Oak grows in nonaeolian sandy soil it does not form woodland. There is evidently little run-off of precipitation along the north slopes of the Cimarron and North Canadian Rivers in the western half of the area. Few drainage courses flow to the south, the dune sand absorbing most of the moisture that falls and retaining it in a form readily accessible to plants. An erosional remnant south of the Cimarron River and west of Kingfisher illustrates admirably the interaction of soils and climate. It consists of a central core of relatively deep dune sand on which Black Jack Oak woodland and tall grass prairie occur. As the depth of aeolian deposit decreases the tall grass proper gives way to mixed prairie, bunch grass etc., which in turn is supplanted by short grass on the soils of extremely tight texture.

Prairie Vegetation

IN the bad lands of the Gypsum Hills and extending eastward into the plains for varying distances the soils have a high alkaline content and a generally tight texture. Numerous "alkali spots" on which only salt grass (*Distichlis stricta Rydb.*) thrives, are found here. The vegetation is in general that of an arid region: mesquite (*Prosopis glandulosa Torr.*), prickly pear (*Opuntia camanchica Engelm.*), yucca (*Yucca glauca Nutt.*) and triple-awn grass (*Aristida spp.*) being the most obvious indicators. Though these drought-resisting forms persist into the hills proper they are there accompanied by many plants adapted to more stable soil conditions, some of which are unique to the locality as far as the area is concerned.

The presence of sand sage (*Artemisia filfolia Torr*). along the north slopes of the rivers is quite characteristic in northwestern Kingfisher and Blaine Counties and southern Blaine County. It also occurs along the slopes of some of the tributaries of the South Canadian River in western Blaine County. A form common to more arid regions, its occurrence adjacent to Jack Oak woodland in northwestern Kingfisher County is worthy of note.

Representative of State

IT would surely be not far wrong to say that tall-grass prairie prevails in the Logan County grasslands and that west of there the grassland types are determined by soil texture. Thus tall-grass prairie is found in Logan County and in western Blaine County but in the intervening portion the grasslands are most commonly of the mixed prairie (bunch-grass) type and not infrequently short grass, with tall grass occurring where the looseness of the soil forms a favorable environment.

In considering the area as a whole one may be struck by a similarity with the general character of the State. Both have more marked relief, lower elevations and more mesophytic vegetation to the eastward. Both have a wide variety of soil types and topography. The influence of comparatively uniform rainfall in the area is offset in many places by conditions of topography and soil which afford a range of plant forms somewhat comparable with that of the State.

Section Program

(Continued from p. 220)

drifting sands but on all types of eroded lands. The search presupposes an intimate knowledge of the processes of erosion and the natural methods of recovery in all climates and on all types of soil and bedrock. Holland grass came originally from the northwest coast of Europe. Kikuyu, another valuable soil binder, came from South Africa. Other plants successful in erosion control have been introduced from South America and Asia. A systematic study of foreign areas having climate and physiography similar to our eroded lands will enable us to capitalize on the experience acquired during a longer agricultural occupance.

Man, through his misuse of land, has accelerated erosion. The present problem is to accelerate its control proportionally. This can be accomplished only through intimate knowledge of erosion processes and the way in which recovery would proceed under normal conditions.

SAMPLING THE WEATHER AT THE OKLAHOMA CLIMATIC RESEARCH CENTER

By Leonard B. Corwin[1]

THE OKLAHOMA Climatic Research Center established by the Soil Conservation Service in cooperation with the United States Weather Bureau, has the distinction of being the most comprehensive undertaking ever attempted for the study of microclimatology and its application to the problems of soil conservation. In an area 30 by 80 miles in extent, including Blaine, Kingfisher, and Logan Counties, 200 fully equipped weather stations have been established. All weather instruments are read simultaneously and at short intervals. In this way it has been possible to trace individual storms as they cross the project area, to observe their behavior, determine their water contribution to each part and to the entire area, and to classify them according to their morphology.

Project Organization

THE detail required in order to develop the concepts presented by C. W. Thornthwaite in his article entitled "Life History of Rainstorms" (Geographical Review, vol. 27, no. 1, January 1937, pp. 92–111)[2] is apparent only when the organization of the project is considered. All of the workers, with the exception of a small scientific and administrative staff, have been supplied by the W. P. A. The weather stations are spaced on an average of 3 miles apart and the observers prepare hourly reports on temperature, wind direction and velocity, humidity, dust, cloudiness, fog, and thunderstorms activity. Precipitation is recorded at 15-minute intervals from 7 a. m. to 7 p. m. That which falls during the night is accumulated and measured at 7 a. m. the next morning. Since the installation of 100 self-recording rain gages on the project, rainfall maps for each half-hour interval during the night have been prepared. These reports are mailed daily to the office at Kingfisher, Okla. If a day is clear and without rainfall, cloud, dust, fog, or frost, about 13,600 individual weather readings are received. If the day is continuously rainy, 9,800 additional readings are required and other miscellaneous observations may add another 3,000, bringing the total number of items to be considered to the notable figure of 26,400 for a single rainy day.

[1] Junior Soil Conservationist (Climatic Research) in charge of Oklahoma Climatic Research Center.

[2] Reviewed by Katherine C. Hafstad, Soil Conservation, vol. 2, no. 7, January 1937.

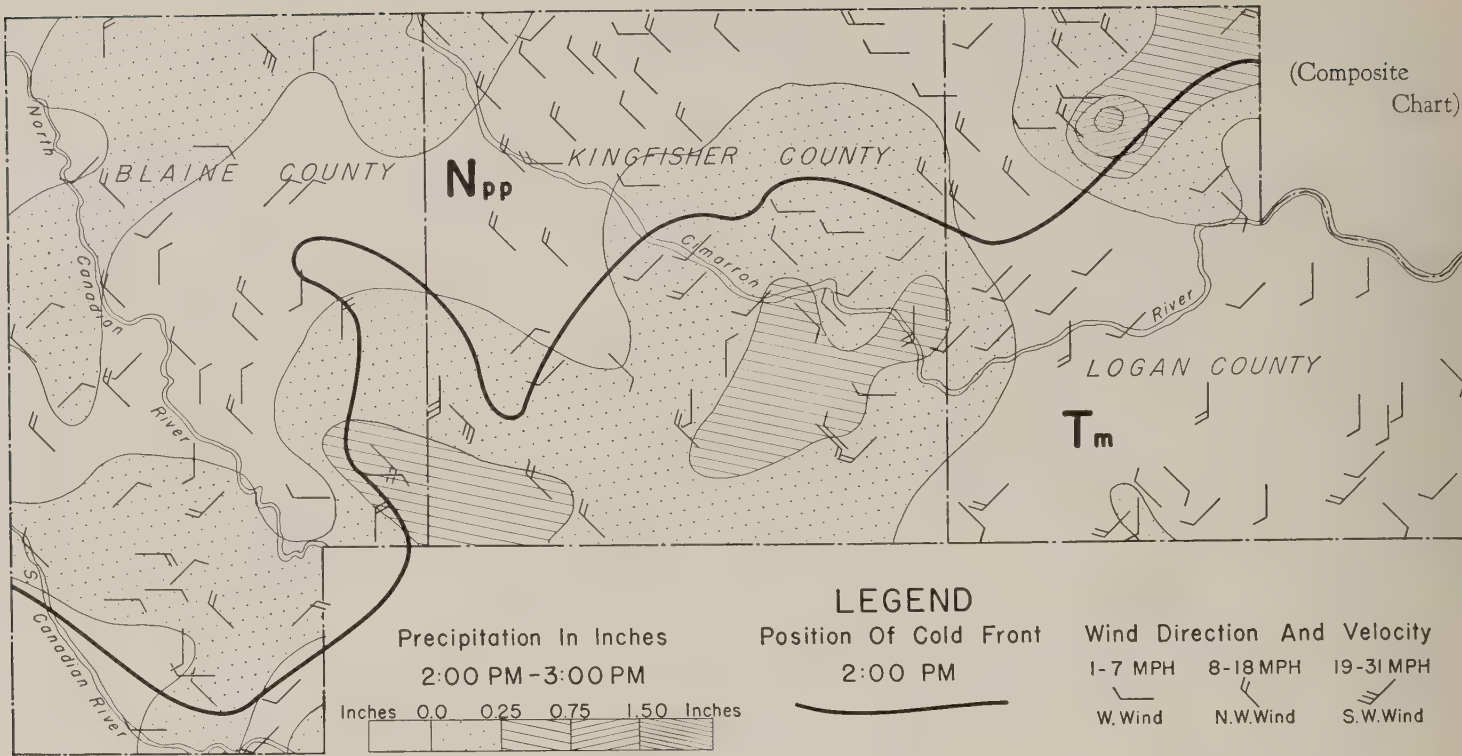
In addition, to transpose these observations, the office staff must compute relative humidity from the readings of the wet- and dry-bulb thermometers, requiring a total of 2,600 computations daily. The wind velocity is recorded by observers in "buzzes" per 2-minute interval. To change this to miles per hour another 2,600 computations being required. Similarly, the rainfall is measured in cubic centimeters in a glass graduate and must be converted into inches of precipitation. The latter may involve as many as 9,800 additional computations for one day.

Climatic Mapping

THE map was selected as the best method for presenting this detailed meteorological information. An average of 120 maps are required for each day, and for a rainy day over 200 are prepared. The maps serve the dual purpose of presenting the information graphically and checking upon the accuracy of the observers. One person reads the data from the observer's records and another plots them on maps. When all the necessary information has been transferred to the maps, lines or isorhythms are drawn connecting points which have equal values of temperature, rainfall, cloudiness, or wind velocity. The direction of the wind is shown by arrows flying with the wind. If one station records values abnormally higher or lower than those surrounding it, it is checked with the observer's report to see that no error has been made in the plotting. If the observer was at fault an "X" is placed after the incorrect value on both the map and the observer's record, and the observation is disregarded in drawing the isorhythms. Similarly, different types of maps are checked against each other.

All errors are reported back to the observers. When too many errors accumulate for one observer or if he continues to repeat the same type of mistake after it has been called to his attention, sufficient justification exists for removing his station. The result has been an unusually high degree of accuracy in the observations as a whole. This is absolutely essential to the success of the project.

THE microclimatic maps are supplemented by four daily maps, prepared for 6-hour intervals, upon which are recorded approximately 50 complete meteorologic observations made by United States

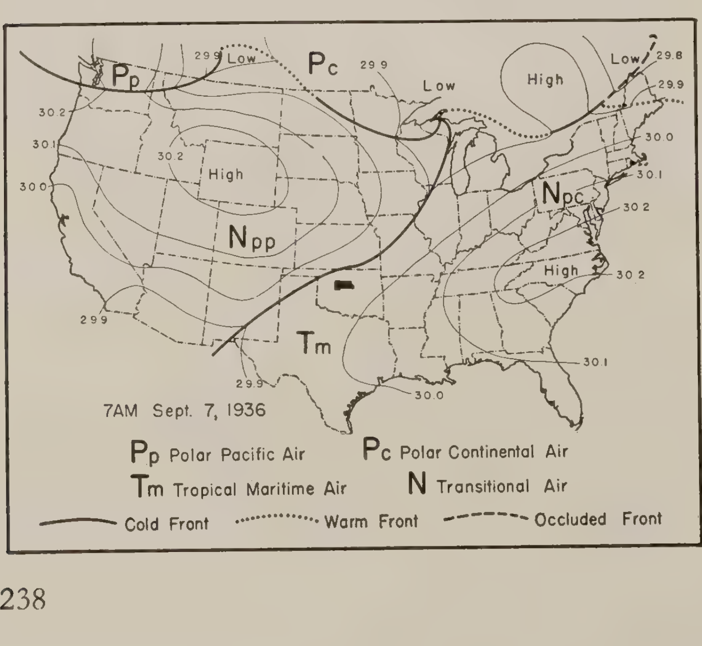


(Composite Chart)

Weather Bureau stations and intermediate airways weather-reporting stations located either in Oklahoma or the States bordering it. In addition, an analysis of the weather map for the entire United States furnishes a still broader view of the meteorologic situation affecting the project area.

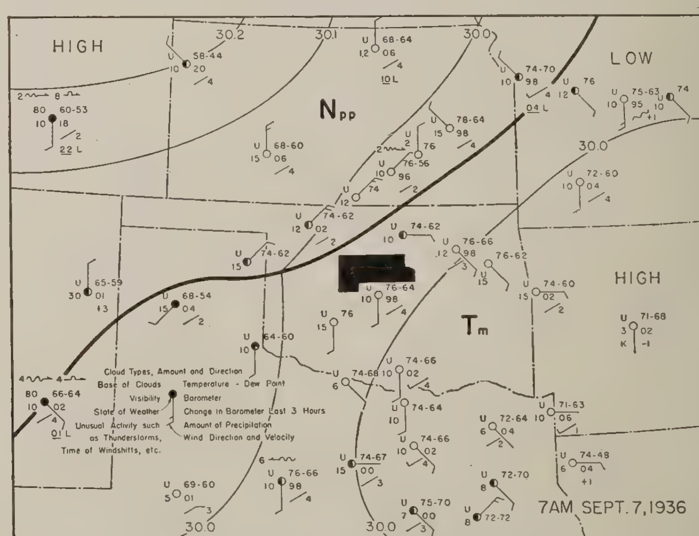
Storm Analysis

Examples of the three types of maps are shown in the accompanying illustrations. The first is a synoptic picture of the weather situation for the United States at 7 a. m. central standard time on September 7, 1936. The boundaries between the different air bodies have been indicated and the air masses have been appropriately labeled according to whether their source lay over a Polar Maritime (Pm), Polar Continental (Pc), or



Tropical Maritime (Tm) region. The significant feature of this map in relation to the Climatic Center is the frontal boundary which lay to the north of the area. This boundary indicates the advance of a Polar Maritime air body into an air mass of Tropical Maritime origin.

The second illustration shows a more detailed picture of the same meteorologic situation at the same time. The accompanying diagram indicates the general grouping and character of the information plotted. The various observations are quite complete. It is to



be noted that nowhere among this network of weather stations is rainfall occurring.

A composite chart showing a part of the information obtained from the observations of the Climatic

(*Continued on p. 244*)

THE PROBLEM OF SOIL EROSION IN ANTE-BELLUM VIRGINIA

By A. R. Hall[1]

Washington, a pioneer soil conservationist, experimented in erosion control at Mount Vernon.

PATRICK HENRY is said to have remarked upon one occasion soon after the Revolution that "since the achievement of our independence, he is the greatest patriot who stops the most gullies." This statement indicates that soil erosion as induced by cultivation was becoming a problem of considerable magnitude at a comparatively early period. What other written evidence do we have to date the beginnings or progress of erosion in Virginia?

We are perhaps safe in saying that soil washing in the interfluvial ridges of tidewater Virginia and in the Piedmont became serious practically as soon as land was brought into cultivation. However, the first generation of farmers and planters had little or nothing to say about it. Little concern was felt about the destruction of a commodity as plentiful as land. Tobacco continued to be "hilled up" with the hoe. Corn land continued to be plowed in straight lines, regardless of the slope, so that furrows were often laid directly up and down a hill. Only with the growing scarcity of virgin tobacco land and the coming of the prolonged agricultural depression at the end of the eighteenth century did the planters begin to think and write about the seriousness of their erosion problem. From this period dates the most abundant documentary evidence of early soil wastage in Virginia.

An Englishman at Mount Vernon

The Father of his Country was one of the first to attempt to prevent the depletion of that country's resources. As early as 1769 he was conducting experiments in plowing and harrowing at Mount Vernon to determine which method would do most to preserve the land. Since long absence from the estate prevented systematic efforts at good farming, Washington thought seriously, a quarter of a century later, of letting out most of his land to English tenants. In a sales letter written with this in view he said—

> A husbandman's wish would not lay the farms more level than they are; and yet some of the fields, but to no great degree, are washed into gullies, from which all of them have not as yet been recovered.

Richard Parkinson, an Englishman who was attracted to Mount Vernon by Washington's offer, found that this was all too true, not only of the estate itself but of the adjacent land along the Potomac. Later, Parkinson settled upon a farm near Baltimore where he had some disheartening experiences with this (to him) novel phenomenon of soil wastage. On land that had been pulverized as he would have done English land he found that:

> . . . the whole of the soil [moved], for an acre together, when a heavy rain fell, from the current in some places cutting gullies, and carrying part of the manure away; and the soil seemed to press in or slip after it.

Parkinson at length concluded that:

> Upon the whole, America appears to me to be a most proper place for the use to which it was first appropriated, namely the reception of convicts.

As we might expect, most of the complaints against erosion came from the Piedmont. An English officer held captive by the Revolutionary forces at Charlottesville and Richmond noted that soil washing in the

(*Continued on p. 243*)

[1] Assistant soil conservationist (Erosion History).

SLOPE FACTORS IN SOIL EROSION

With Illustrations from the Kentucky Karst

By H. Bates Brown, Jr.[1]

SLOPE has long been recognized as one of the major factors in determining erosion potential. In an attempt to define erosion hazard in relation to slope, the Soil Conservation Service has divided all slopes into four groups and has made major land-use recommendations accordingly. These classes, designated by the symbols A, B, C, and D, are all based on the degree of slope. Slopes of group A, the gentlest, are expected to experience a minimum of erosion under normal conditions of tillage. D slopes are the steepest and it is recommended that they be taken out of cultivation. The B and C groups, intermediate in slope, are regarded as needing erosion control measures if cultivated.

While the original concept of four slope classes has been maintained, it has been modified locally. Subdivision of the major groups have been made in different regions to indicate more specific land-use recommendations. Likewise there has been a constant refinement in the definitions of the various slope classes. For example, in South Carolina group A includes slopes up to 3 percent, but in some of the more northern States the limit is extended to 5 percent.

Although slope classification according to the degree of slope has the advantage of being on a workable quantitative basis, it has the disadvantage of leaving out of consideration certain other recognized qualities of slope which may be even more significant than gradient. One of the most obvious hazards of slope that is not apparent in an instrumental determination of the degree of slope is its length. In the case of a long slope, serious erosion often occurs near the base where concentration of water is naturally greatest. An A slope lying at the foot of a long B slope may be the more susceptible to erosion because of the increase in volume of water coming off the long slope above. The construction of terraces may alleviate the condition to some extent by diverting the surface run-off from the lower lying lands, but by further lengthening the course which the water must take before reaching the base level, it may lead to a greater concentration of run-off and thus increase the hazard of gullying.

[1] Junior soil conservationist (Physiographic Research), Section of Climatic and Physiographic Research.

NOTE.—*The problems of soil erosion in the Kentucky karst are being more completely treated in a forthcoming manuscript by S. N. Dicken and the writer.*

Direction of Slope

IN some regions the direction which a slope faces may be more significant from the erosion standpoint than is the degree with which it declines. In parts of Kentucky and Tennessee very striking contrasts in the landscape may be observed, depending on the direction toward which the land slopes. In the hilly "knob" country, underlain by flat-lying beds of limestone, south-facing slopes are so denuded of their soil cover that they consist of virtually nothing but bare limestone outcrops. In striking contrast are the adjacent north-facing slopes which are mantled with deep soils even though the degree of slope is commonly

The effect of exposure on erosion. The pictures on these two pages show the opposite sides of the same knob. That on the left is of the south slope; that on the right the north slope. The soil has been almost completely removed on the south side, sloping at 23 percent; whereas, the north side, although much steeper (33 percent), retains a good deep soil which is being tilled with a minimum of erosion loss. The corn in the background is the best on the farm, which includes a considerable amount of relatively level land. The few tobacco plants appearing in the foreground have been left to make seed, mute testimony as to what this farmer thinks of the tobacco grown on this steep but productive hillside. The bedrock is flat-lying limestone; the pictures were taken at about the same elevation on the two sides of the knob; thus, the parent soil material is the same.

greater. Under virgin conditions the vegetation of the southerly slopes is a sparse growth of red cedar, scrub oak, and bluestem grass, growing on patches of thin soil which remain in fissures between ledges and boulders of limestone. In contrast, dense oak-hickory forests cover northern exposures. Steep northerly slopes are often cleared and cultivated while gentler southward-facing slopes remain in their virgin denuded condition, the soil being too thin to warrant clearing.

Eastward- and westward-facing slopes show a similar contrast but to a lesser degree. Eastward slopes resemble those facing south, while westward and northward slopes are comparable. The slopes listed in order of increasing erosion hazard would be north (least denuded), west, east, and south.

Effects of Exposure

THE effect of exposure on erosion appears to be especially significant in those parts of the country which experience a great number of alternations in freeze and thaw in the course of the year and along the borders of those regions which are covered with a snow blanket for a considerable length of time. In such places, northward-facing slopes, receiving sunlight at a lesser degree of incidence and for a shorter length of time, are protected during long winter periods by a continuous cover of snow or frozen soil. The relatively sunny southward slopes are thawed out more of the time and subject to the erosive action of running water and to other denudational processes accompanying thaw. On many days when the northward slopes remain frozen the southward slopes will thaw out in the daytime under the more direct rays of the sun only to freeze again at night. Consequently, the heaving of soil particles by growing ice crystals is repeated more often on southward slopes. The frequent heaving not only prepares the soil for ready removal by running water but is significant in aiding the gradual downhill creep. The more denuded soil and the greater evaporation on the sunny southern exposures are conditions unfavorable for vegetative growth. The reduced vegetative cover on southward slopes creates an additional erosion hazard.

More rapid erosion on southward-facing slopes is a natural phenomenon—one that cannot be controlled by man. That advanced erosion on these slopes has been the condition for countless ages is attested by the fact that they are usually gentler than northerly slopes. They have been gradually worn down to a gradient less than that of the other slopes.

The effect of exposure on the steep limestone hills of Kentucky and Tennessee becomes striking and easily recognized because of the abrupt contact between the soil and rock. The loose soil lying directly on the solid limestone base is very easily swept off. On southern exposures where soil removal processes are most active, the bleached white limestone outcrops and the totally different vegetation aid the observer in detecting the greater erosion. The strikingly contrasted conditions of the limestone slopes serve to emphasize the hazard to southward-facing slopes in

other regions where the process may be active but less noticeable.

It is to be assumed that when erosion is accelerated, as by cultivation, the natural process will work with greater force. That southward slopes are in greater danger than those that face the north, even though the southward slopes may have less gradient, is indicated by the Kentucky case. Many southward-facing hillsides with a slope of 25 percent or less have lost almost their entire soil cover and the bed rock is exposed. On the other hand, northerly slopes of 35 percent retain a good soil, several feet thick, above the same type of bed rock. Intelligent farmers have demonstrated that with conservative management this steeply sloping north land can be tilled with a minimum of erosion loss (see illustration). Their methods consist of plowing on the contour, using rotations to return organic matter to the soil periodically, and plugging every incipient gully that may appear.

Another hazardous quality of slope, which is not apparent in a statement of average gradient, is the form of the profile. Convex slopes are much more susceptible to erosion than are the concave. In the case of the convex profile the steepest gradient occurs near the base of the slope, which, as already pointed out, is particularly susceptible to erosion. Thus, erosion hazards are augmented. Convex slopes are especially susceptible to deep gullying, for that form of surface is directly opposed to the parabolic curve which the course of all streams, including those flowing in gullies, must reach before becoming graded and permanently stabilized.

The position of the land with respect to base level, whether the land is sloping or not, must also be considered in evaluating the erosion potential. Kentucky again furnishes an extreme example for this point. In the karst lands, underlain by thick beds of pure limestone, there is a notable scarcity of surface streams, the major drainage being underground. Solution in the limestones is so pronounced that underground channels have been cut out by dissolution and have become occupied by flowing streams. Surface run-off is supplied to the underground streams through numerous sinkhole openings. In this condition the soil material, which is simply a residue from solution of the upper limestone surface, lies perched, as it were, well above the base of wastage which has been established by the underground streams. Under natural conditions the soil apparently maintains itself in this precarious position, but when this delicate equilibrium is disturbed, as by an abnormal concentration of run-off, gullies form and rapidly cut down to the underground base of denudation.

The karst furnishes an excellent example of another hazard particularly significant from the standpoint of culturally accelerated erosion. Although it has the appearance of being a relatively flat country, it is made up of innumerable short slopes surrounding small depressions, commonly called sinkholes or basins. In planting row crops this is particularly significant. The great number, small size, and irregular distribution of basins limits the practicability of such soil-conserving measures as contour plowing, terracing, and strip cropping. Because of the short slopes the farmers are frequently forced to run their furrows without regard to topography. With this tillage practice the rows run on the contour in some places but at right angles to the contour in others. Rills and eventually gullies rapidly develop where the furrows run downhill as they cross small basins.

The Flood Hazard

Culturally accelerated erosion in the land of sinkholes has introduced another farming hazard—flooding. The most fertile soil is to be found in the basins inasmuch as the basin soil is mostly an accumulation of topsoil washed down from the surrounding ridges. But crop success cannot be depended upon because of the flood hazard. The basins, being clogged sinkholes, suffer poor drainage as the natural sinkhole drainage has been disturbed. After heavy rains ponds frequently form. If the water remains on the surface many days, as it does during wet years, crops are ruined.

Although the factors mentioned in this article are especially applicable to limestone lands, those in Kentucky in particular, the same factors have a significance of varying importance in other regions. Indications that southward-facing slopes are especially susceptible to erosion have been observed in such widely separated sections of the country as South Carolina, New Jersey, Idaho, and California. The matter of the susceptibility of convex slopes, common to many regions, is closely related to the principles of base level—a consideration of world-wide significance. Where all other slope factors are constant erosion hazards may be assumed to increase with gradient. But other factors are never constant and slope is but one of many varying factors in erosion. Consequently, intelligent land planning and the application of workable erosion control practices in any locality requires an intimate knowledge of the prevailing conditions.

Erosion in Ante-Bellum Virginia

(Continued from p. 239)

upper Piedmont caused the James River to look like a "torrent of blood" during the freshets of 1779. A certain Dr. William Meriwether informs us that the insidious process of sheet wash had done widespread damage in Amelia county by 1790. By that date the gray surface soil of much of the county had been swept away, leaving the subsoil of hard, tenacious red clay exposed. A Prince Edward County farmer writing at a later time, estimated that very little hilly land cleared for more than 20 or 30 years was of any value because of the prevalence of soil washing. The inroads of erosion in the counties just east of the Blue Ridge, notably on soils of the Davidson series (the "red lands"), was very disquieting to early Virginians. This was regarded as one of the best agricultural areas of the State, yet one observer spoke of it as having been washed and gullied and as having presented the impression of nakedness at the end of the eighteenth century. Speaking of the area around Monticello, Thomas Jefferson complained that "fields were no sooner cleared than washed." James Madison, who lived in this same region, put the matter a little more conservatively, but none the less strikingly when he declared that without some soil-saving methods of cultivation the ownership of "red lands" was little more than a lease for years.

Early Agriculturists Concerned

In the hilly parts of the State erosion as induced by cultivation had its counterpart in the overwashing of valuable lowlands and the silting of stream channels, especially in the tidewater region. By 1813 John Taylor, of Caroline County, was calling this fact to the attention of the country.

> The disaster [he said] is not terminated by the destruction of the soil, the impoverishment of individuals, and transmission of a curse to futurity. Navigation itself is becoming its victim, and in many parts of the United States, our agriculture has arrived to the insurpassable state of imperfection, of applying its best soil to the removal of the worst farther from market.

Thomas Moore, of Maryland, writing in 1801, was one of the first to attempt to describe in detail the way in which agricultural practices caused soil erosion. He contended that the customary practice of plowing to a depth no greater than 4 inches was the cause of most erosion. Moore thought that, as a result of shallow plowings on southern fields the surface of the soil had become, by 1801, the whole depth of plowing lower than when first cultivated.

> What further proofs need we [he asked], to convince us that the practice of agriculture, particularly in the Southern States, is miserably defective, than the deserted old fields that so frequently present their disgusting surfaces from Susquehanna to Georgia?
>
> *   *   *   *   *
>
> * * * that this is a necessary consequence of *shallow ploughing* on lands that are in any degree hilly, in this climate, I trust has been satisfactorily proved.

Control Practices

While the urgency of the erosion question was gaining widespread recognition, forward looking agriculturists set out to "do something about it." Deeper plowing, the adoption of systematic rotations, the growing of cover crops, and the reduction of acreages in clean-tilled crops were advocated and practiced by a good many farmers. The practices of contour plowing, hillside ditching, and terracing were introduced in Virginia during the first half of the nineteenth century. Nevertheless, if these were good beginnings they were only beginnings. On the eve of the Civil War much still remained to be accomplished, as the two following quotations, dated 1856, indicate. One observer complained that Virginia was "bleeding from a thousand wounds inflicted by improvident husbandry" and that "we behold everywhere around us stunted vegetation, scanty crops, poverty of soil, and innumerable gullies and galds." After quoting John Taylor's passage regarding the silting of streams, another agricultural reformer lamented that:

> Nothing has yet been done to wipe from our agriculture the reproach of [Taylor]. The alluvial treasure, annually washed from our forests and badly cultivated soils, and floated down our rivers, continues to serve no other purpose but to obstruct our navigation and poison our atmosphere. Not one scientific effort has been made to arrest it in its progress to tidewater, and none to appropriate it below.

Thus, our ancestors found, just as we of today are finding, that the problem of erosion was not to be solved in a day.

Highway Menace

(Continued from p. 232)

this aspect of erosion; and as a start which will involve no special legislation, it is suggested that such agencies in key communities bring the matter to the attention of county commissioners and engineers. With a degree of intelligent supervision of road-working crews much of the damage can be arrested. And a few counties would serve as demonstration projects, thus arousing the interest of authorities elsewhere.

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

ESSAYS IN GEOBOTANY. Edited by T. H. Goodspeed. Berkeley, Calif., 1936.

This volume, published in honor of the scientific achievements of William Albert Setchell, includes a group of papers assembled with the idea of presenting a unified study of plant associations and rate of plant migration as related to climate and soil moisture. With the assumption that an understanding of the paleontologic record of a region, as well as of the living plants, forms the basis for any complete comprehension of modern vegetation, the article on succession and distribution of Cenozoic floras around the northern Pacific basin by Chaney, occupies a place well toward the front of the book. Following this Frederic E. Clements presents an extensive discussion of the origin of the desert climax and climate in North America. The objects of the paper are to explain the distribution of the typical dominant of the desert climax, *Larrea tridentata*, and its associates over an area much wider than that in which they are climax in the southwestern part of the United States, and their rapid spread in the wake of overgrazing and disturbances by man and rodents. In assembling his evidence, the author proceeds from the relicts which are still present in the desert, are few in the climax itself, and more frequent near the mountains, through the "transads" to and including the species that occur in the desert and on the side of it. Attention is given also to the changes that have taken place farther away in the grassland without transforming it into desert.

As background for the evidence derived from the migration of the desert climax in the Southwest and the evolution of endemics, the author presents an evaluation of fossil plants from Miocene to Pleistocene and associated fossil animals.

In a geographic study of the strand and dune flora of the Pacific coast of North America, William S. Cooper presents results of a general survey of plant species inhabiting the actual strand and areas of moving sand and species which occupy the surfaces of stabilized dune. Summarizing the flora discovered, the author states that "* * * we find first, a group of 26 species definitely derived from stock of the local hinterland, representing either genera confined to the region or local sections within widespread genera. This group includes one-third of the species of strand and moving dunes and practically all those of stabilized dunes. The genera represented are mainly characteristic of arid and semiarid habitats. Of the remaining 17 species, 14 (all of strand and moving dunes) are of subarctic or north temperate origin. * * * Three species (2 of shifting, 1 of stabilized dunes) are derived from the subtropics and South America."

Sampling the Weather

(Continued from p. 238)

Center comprises the third illustration. Here the precipitation pattern observed from 2 to 3 p. m. (determined by adding the amounts which fell during the four 15-minute intervals), is superimposed upon a wind direction and velocity chart of observations taken at 2 p. m. The frontal boundaries between the polar and tropical air bodies are indicated by the heavy continuous line. The complex character of the boundary is revealed only in this highly detailed analysis of the Oklahoma Climatic Research Center and it has been shown by Thornthwaite that these sinuate complexities bear a genetic relationship to rainstorm morphology. Actually, within a 2-hour period, approximately 5,000,000 tons of water were poured upon an area of 100 square miles in northwestern Logan County as a result of this atmospheric configuration.

The significant results that have already been obtained from the Oklahoma project regarding the characteristics of individual rainstorms and their direct bearing upon soil erosion and flood hazards has led to the establishment of a similar climatic research project in the Muskingum watershed in Ohio. Here a battery of 500 weather stations distributed over the 8,000 square mile watershed will be of great importance in comparing the behavior and character of storms in two entirely different climatic provinces. But of even greater significance will be the liaison that will exist between this climatic study and the hydrologic investigations already in operation in the Muskingum area. For the first time detailed data will be available for all phases of the hydrologic cycle. Fourteen flood-control dams and numerous stream-gaging stations are maintained in the Muskingum conservancy district, and the results of these investigations will be correlated with the soil-conservation climatic study. The two associated types of study should lead to a better understanding of the critical conditions that produce floods.

Rotation of Gully Heads

(Continued from p. 229)

new cutting heads, the end gained would fully justify such procedure.

The principle of rotation of heads would not be applicable to all gullies. It would require careful consideration of soil, climate, vegetation, crops, and slope. Physiographic studies of the process of gully cutting under different environmental conditions and agricultural systems, however, should make possible wider use of the practice of rotating gully heads to control erosion—a practice which has proved effective where tested and one which involves a minimum of expense to the farmer.

U. S. GOVERNMENT PRINTING OFFICE: 1937

SOME RESEARCH STUDIES RELATED TO SOIL AND WATER CONSERVATION

Compiled by Mrs. Etta G. Rogers, Publications Unit

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Results of Field Crop, Shelterbelt, and Orchard Investigations at the United States Dry Land Field Station, Ardmore, S. Dak., 1911–32. Circular 421. January 1937.

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SOIL CONSERVATION

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MAY AGRICULTURE AND FLOOD CONTROL 1937

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Compiled by Mrs. ETTA G. ROGERS, Publications Unit

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SOIL CONSERVATION

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Chief, Soil Conservation Service

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AGRICULTURE'S *New Approach to Flood Control*

by A. L. Patrick[1]

ON JUNE 22, 1936, Congress passed what is known as the Omnibus Flood Control Act (Public, 738—74th Cong.). This for the first time in history authorized a coordinated land and water program for flood control.

The wording of section 2 states "That, hereafter, Federal investigations and improvements of rivers and other waterways for flood control and allied purposes shall be under the jurisdiction of and shall be prosecuted by the War Department under the direction of the Secretary of War and supervision of the Chief of Engineers, and Federal investigations of watersheds and measures for run-off and waterflow retardation and soil erosion prevention on watersheds shall be under the jurisdiction of and shall be prosecuted by the Department of Agriculture under the direction of the Secretary of Agriculture, except as otherwise provided by act of Congress . . ."

IT SHOULD be noted that section 2 actually sets up the purpose of the act while section 6 authorizes the carrying out of specific work on certain watersheds: "The Secretary of War is hereby authorized and directed to cause preliminary examinations and surveys for flood control at the following-named localities, and the Secretary of Agriculture is authorized and directed to cause preliminary examinations and surveys for run-off and waterflow retardation and soil-erosion prevention on the watersheds of such localities; the cost thereof to be paid from appropriations heretofore or hereafter made for such purposes * * *."

Two hundred twenty-two watersheds were set up under this act and many additions are being made by the present Congress. The wording of section 6 as to location of the places on the watershed where work is to be performed is somewhat confusing. It is easy to understand why, when one realizes that the act was drafted originally with exclusive regard to downstream engineering structures. The words "watersheds of such localities" is interpreted to mean that treatment may be planned for all the land drained by a stream from its origin to the point nearest the mouth.

(Turn to next page)

[1] Special Assistant to the Chief, Soil Conservation Service, Washington, D. C.

The act authorized $10,000,000 to be appropriated and expended in equal amounts by the Departments of War and Agriculture for carrying out any examinations and surveys provided for in the act. Congress adjourned last year without actually appropriating any money for this purpose. The present budget contains an item of $1,000,000 for this work, half of which would be used by the Department of Agriculture. The hearings on the Flood Control Act were just getting under way when this issue went to press.

Three Bureaus Concerned

CONGRESS placed upon the Secretary of Agriculture the responsibility for carrying out the provision of the act regarding run-off and waterflow retardation and soil-erosion prevention in the watersheds. The Secretary has stated that while many of the agencies of the Department will be able to make worth-while contributions, the three primarily concerned are the Bureau of Agricultural Economics, the Forest Service, and the Soil Conservation Service.

M. S. Eisenhower, Director of Information for the Department, was appointed to represent the Secretary in correlating the Department's efforts with those of the War Department and other Federal agencies, and to serve as coordinating officer in the Department. F. A. Silcox, Chief of the Forest Service; H. H. Bennett, Chief of the Soil Conservation Service; and A. G. Black, Chief of the Bureau of Agricultural Economics, serve as an advisory committee with Mr. Eisenhower in formulating policies to be developed, and in establishing the proper procedures within the Department for the efficient conduct of the work.

Committee Set-Up

A "Flood Control Coordinating Committee", consisting of A. C. Ringland (chairman), E. N. Munns, and C. I. Hendrickson, representing the Soil Conservation Service, the Forest Service, and the Bureau of Agricultural Economics respectively, has been set up. This committee has organized machinery and worked out relationships so that when funds are available the preliminary phases of the work can be started without undue delay. Preliminary examination outlines have been prepared. Field committees consisting of representatives of the three bureaus have been named for each of the watersheds mentioned in the bill. Field liaison officers to serve for the field committees in contacting district Army engineers with reference to the holding of public hearings have been named and are functioning. An understanding of working relationships between the Department of Agriculture and the Office of the Chief of Army Engineers has been arranged.

Watershed committees covering work in S. C. S. regions 1, 2, 3, 4, 5, 6, 7, and 9 have met, and methods of procedure for carrying out preliminary examinations have been explained. Cost estimates have been prepared in the field and sent to Washington.

THE preliminary examinations and the surveys are two distinct features of the act. The former is to provide data for conclusions as to whether a watershed survey should be recommended. Surveys are comparatively costly and, as a consequence, are not to be recommended unless there is likelihood of a worth-while program evolving as a result. There are other objectives of the preliminary examinations, such as determining which of the departmental agencies should assume the leadership of various watershed surveys, arriving at some idea as to their cost, and arranging the order in which they should be surveyed.

The Department is responsible to Congress for compiling information and reporting upon every watershed named in the act. In cases where it is evident that a survey will not be recommended detailed preliminary examination reports will not be made. Disapprovals will have to be thoroughly justified, however, since the reasons for rejection will be submitted to Congress by the Secretary.

THE failure of either of the two Departments to recommend a watershed survey will not necessarily mean an adverse report by the other. Both Departments will submit separate reports for each watershed, and their work does not overlap, since each is charged with a specific phase of the control problem.

(Continued on p. 266)

Watershed Treatment and Flood Control

By R. H. Davis [1]

IN THE PAST flood control has generally been looked upon as a program for controlling large volumes of water which have become concentrated in major streams by means of levees, floodways, dams, and storage reservoirs. The importance of such installations on major waterways and their tributaries should not be minimized. We must not overlook the fact that floods occurred before settlement and use of the land. Therefore, downstream installations have a very definite function and must be permanently depended upon as an important phase of flood-control work. There is plenty of evidence, however, that man through his activities with ax, plow, herds, and fire has created conditions which make for more frequent and more extensive floods, and insofar as this is true it should be possible for man to establish effective flood-control measures. It is in this margin of difference between natural conditions and man-modified conditions that watershed treatment for flood control may be expected to make its contribution.

In the Omnibus Flood Control Act of 1936, Congress gave recognition to "run-off and waterflow retardation and soil erosion prevention on watersheds" as having a part in flood control. It should be emphasized that, in passing this act, Congress did not condemn downstream control works. The upstream investigations, and the control measures which may subsequently be based on them, are intended simply to supplement and be coordinated with control operations downstream. Conservation workers, engaged as they are in a program to conserve soil and water on the land, are directly interested in, and have a material contribution to make to the mitigation and control of floods. In light of the relation between soil- and water-conservation practices and flood control, it is desirable to evaluate the effectiveness of such work by a careful analysis of the many factors involved in the whole field of land-water relationships.

Just as there are limitations to depending on watershed treatment alone, so are there also limitations to downstream control when used by itself, and these limitations should be recognized by those engaged in flood-control planning. Programs limited to downstream installations do not take into consideration three important phases of the whole problem of accelerated run-off and its attendant evils.

[1] Inspector, Division of Conservation Operations, Soil Conservation Service, Washington, D. C.

First. They make no provision for control of floods which occur periodically on the thousands of small watersheds scattered from one end of the country to the other. These small watersheds vary in size from a few hundred to several thousand acres, and each of them presents a very serious problem to the residents of the valleys. The floods in these individual small valleys may be caused by rains of wide aerial extent and may give rise to critical flood conditions in the larger tributaries downstream. Or, as is often the case, the local flood may be caused by a local rain of high intensity with no serious consequences resulting except in the immediate storm area. Undoubtedly, the sum total of damage occurring in these upper tributaries during the period of a year, or over a period of years, amounts to considerably more than the spectacular catastrophies occurring along the major waterways.

Second. Downstream flood control leaves entirely out of the picture the importance of conserving water on the land where it falls so that it may be put to some useful purpose either by promoting the growth of crops or by replenishing underground water supplies. Scarcely a year passes that does not see in certain localities heavy rains giving rise to serious flood conditions and later in these same communities periods of drought with depletion of soil moisture and ground water supplies. The replenishment of soil moisture and ground water storage are highly important in themselves, aside from the problem of minimizing flood flows.

Third. Flood control limited to downstream work does not take into consideration the conservation of the land from which the flood waters originate. This problem must not be ignored. It is important both from the standpoint of conserving soil resources for sustained agricultural uses and from that of reducing the sediment carried by flood waters. Through shoaling of stream channels and silting of storage reservoirs, flood damage is greatly augmented by the sediment load carried by the stream. The effectiveness of many downstream control structures is thus impaired. Damage to farm lands and other property along the flood plains by deposition of debris is also a most important consideration.

Fundamental Considerations

THERE ARE so many ramifications to the precipitation infiltration run-off relationship that it is impossible to say, quantitatively, just how effective

watershed treatment can be with respect to minimizing floods. Indeed, it probably never will be possible to derive formulas for determining in advance the effectiveness of upstream control. Since there does exist such a heterogeneous variety of factors influencing this relationship, and since the relative importance of these factors varies from watershed to watershed throughout the country, it is important in order to study the problem that it be broken down into its component parts. After this has been done and each factor weighed separately, it is then easier to visualize the influence of all of these factors operating together.

By referring to the illustration of the hydrologic cycle, it can be readily seen that the critical problem is the manipulation of the precipitation as it comes in contact with the earth's surface so as to get a larger proportion of it into the soil rather than to allow it to run off. In other words, we must use the land as a reservoir for water. Few people realize the tremendous possibilities which the land offers in this respect. The soil is not an impervious mass, as is sometimes considered, but rather a loose, porous body, capable of absorbing great quantities of water if given the chance. It is the most effective fresh-water reservoir available.

The infiltration and the water-absorbing capacity of soils are, of course, dependent on a number of factors, the principal ones being intensity of precipitation, slope of the land surface, nature of the underlying strata, characteristics of the soil profile, soil porosity, organic content of the soil, extent of soil cover, and presence of mechanical impedimenta to run-off. Of the factors enumerated, only the last four are subject to modification to any extent.

Porosity of three representative soils [1]

Soil type and location	Depth of sample	Porosity	Calculated maximum possible water storage of the top 3 feet [2]
	Inches	*Percent by volume*	*Inches*
Vernon fine sandy loam, Guthrie, Okla.	0–2½	43.3	14.4
	2½	41.5	
	8	41.7	
	22	39.4	
	38	40.2	
Muskingum silt loam, Zanesville, Ohio.	0–3½	48.1	16.2
	3½	45.1	
	9	47.8	
	17	45.5	
	32	31.3	
	54	32.7	
Marshall silt loam, Clarinda, Iowa....	0–6½	55.9	20.7
	6½	56.4	
	18½	60.3	
	32½	58.7	

[1] Middleton, H. E., Slater, C. S., and Byers, H. G. The physical and chemical characteristics of soils from the erosion experiment stations—second report. U. S. Dept. Agr. Tech. Bull. 430, 1934.

[2] The figures under this heading were calculated by Dr. Middleton but not included in the publication.

The porosity of soils varies greatly with the inherent characteristics of each individual soil type. However, it may be markedly improved through increase of organic matter, activity of micro and macro flora and fauna living within the soil, and the decay of plant roots which leave channels to more rapidly conduct water into the soil. An illustration of the amount of pore space possessed by different soils can be obtained by referring to the foregoing table.

The right-hand column showing the maximum quantity of water which these soils would hold if all the pore spaces were filled with water is, of course, a theoretical calculation. The extent to which the pore space is actually filled when it reaches its total water-holding capacity varies with soil types, and further studies are needed to determine this for given soils. Assumming that only 50 percent of this space is available for water, a relatively easy accomplishment with most soils under proper treatment, it can readily be seen that the upper 3 feet will take care of all except the very heaviest rains. This is to say nothing of the water-holding capacity of the material between the top 3 feet of soil and the ground water.

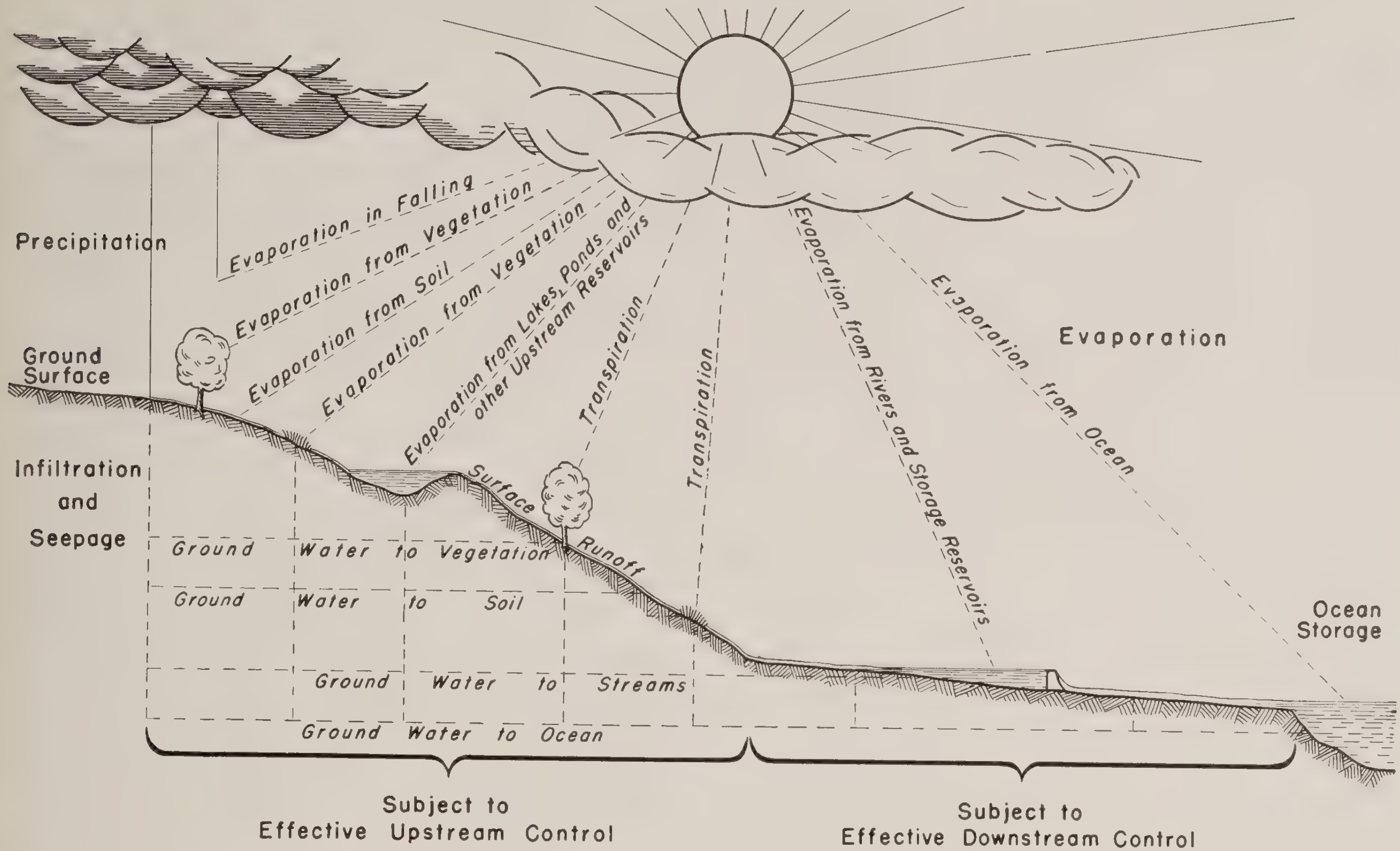
Many statements have been made to the effect that after the surface soil reaches a so-called state of "saturation" it is then unable to absorb any more water. These statements cannot be substantiated because as the surface reaches such a state and can no longer hold water against the pull of gravity, soil water moves downward into the next lower layer and additional water is absorbed above. Through continuation of this downward movement of seepage water contact eventually is made with the ground water supplies, which when replenished flow out into streams, thus setting up a natural circulation. Although during periods of prolonged rainfall shallow seepage from certain soil types may reach streams in time to contribute to flood crests, generally seepage water is sufficiently delayed so that this does not occur.

Vegetal Cover—Influence on Regimen of Water

THAT vegetal cover and its accumulated litter play a very important part in the utilization and control of water is substantiated by a mass of experimental evidence. This is brought about in the several ways enumerated below:

1. Interception of precipitation.
2. Transpiration.
3. Reduction of evaporation from the soil.

THE HYDROLOGIC CYCLE



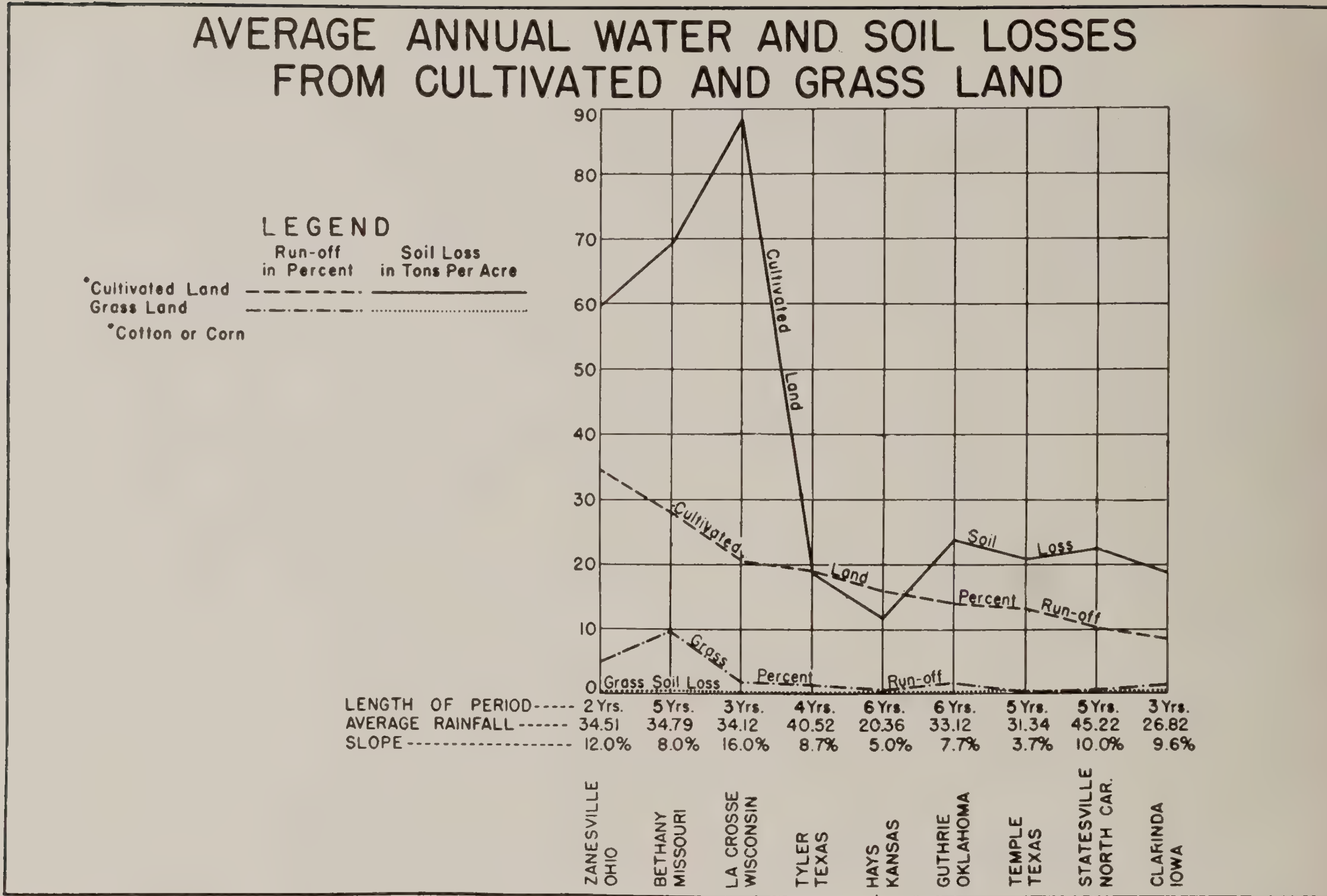
4. Absorption of water by vegetal litter.
5. Mechanical obstruction to run-off by vegetation and litter.
6. Retardation of snow melt.
7. Protection of soil against freezing.
8. Increased infiltration by minimizing clogging of pore space.

The relative importance of each of the foregoing factors varies with type of vegetation, season of year, inherent characteristics of the soil and underlying strata, climatic conditions, etc. It would be most difficult, if not impossible, to isolate the relative influence of each factor for any given set of conditions. It is the combination of several or all of these factors which has given rise to the striking differences noted at all the erosion experiment stations between run-off from grass or forest areas as compared with cultivated land. Invariably, through rain after rain, the effectiveness of good vegetal cover in reducing run-off stands out in a most striking manner at these centers of study as seen in the accompanying table. The quantitative determination of the influence of sod-forming crops on run-off and soil losses, as compared with losses from intertilled crops, is undoubtedly one of the major contributions to modern agricultural science.

Frozen soil conditions are often given as a contributing factor in causing floods. Without doubt this is an important consideration, but we must not overlook the fact that the protective vegetal cover, with the snow which it may hold, has great value in insulating the soil and in minimizing frost penetration. Numerous investigations and observations have proved that soil with a good protective covering of vegetation will resist freezing to a much greater extent than bare ground. Snow cover adds to this resistance. Therefore the attributing of floods to frozen soil conditions over an entire watershed is only assumption, unless thoroughly substantiated by fact.

Other Protective Measures Needed

CERTAINLY no one would advocate the growing of grass or trees on all lands in order to provide adequate watershed protection. It is generally estimated that 350,000,000 acres of cropland would be the very minimum required to meet the food and fiber requirements of our population. However, all but approximately 75,000,000 acres of this required cropland is in need of protection, to varying degrees, against run-off and erosion. The extent of this needed protection depends on slope, degree of erosion, soil characteristics, climatic conditions, and prospective land use.



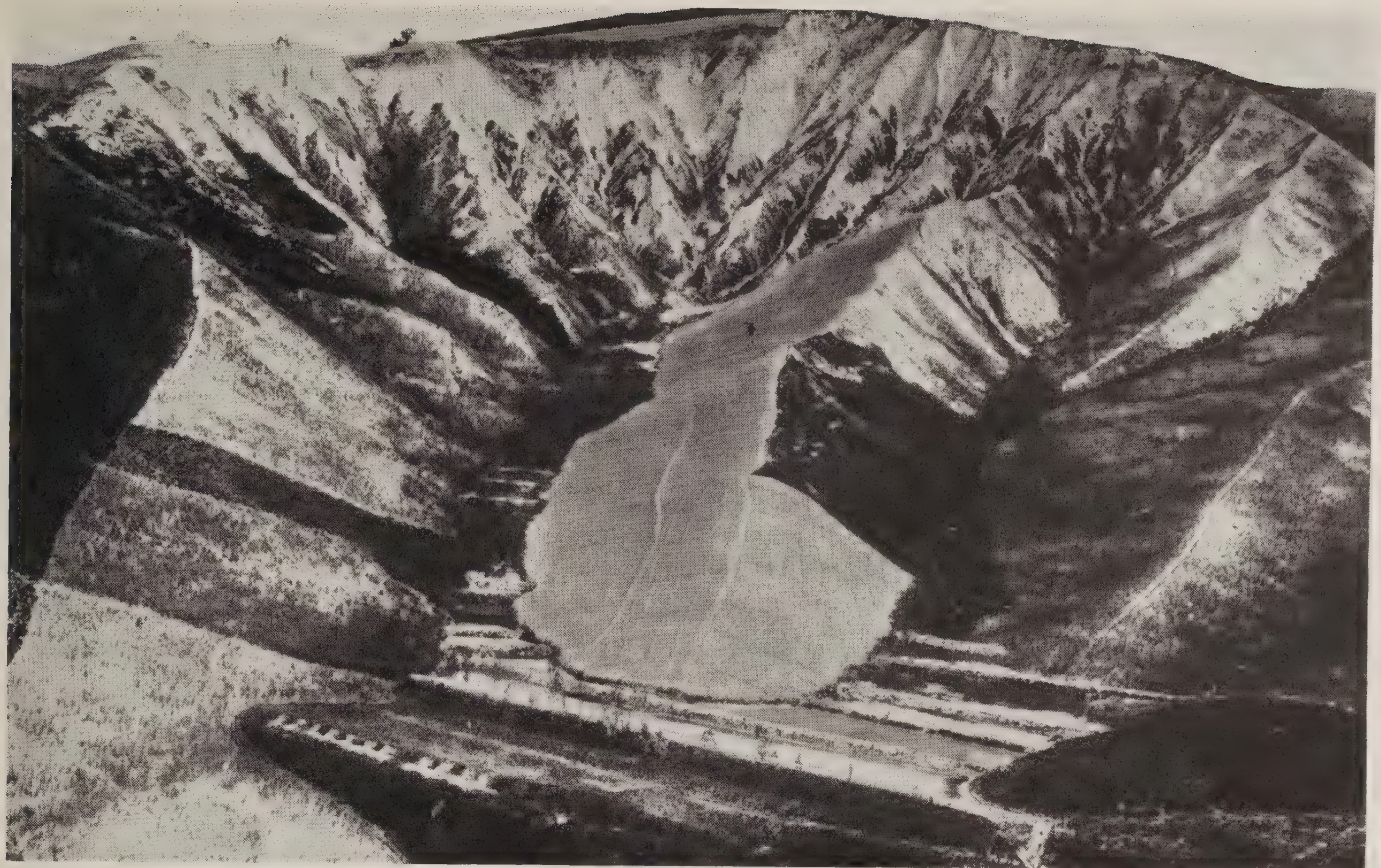
It is generally recognized that such practices as improved crop rotations, winter cover crops, controlled grazing, contour farming, strip cropping, terracing, contour furrows, make a very definite contribution toward the conservation of water and soil. It is also recognized that structures of various kinds materially contribute to the reduction of water and soil which otherwise would have to be dealt with downstream.

It is unfortunate that quantitative measurements showing the relation of land use and water-conservation practices to floods are not available for large watersheds. Most experimental data thus far have been secured from small areas, and have left out of consideration the extent of concentration which, from the downstream standpoint, is more important than total run-off. There is sufficient evidence, however, to indicate the trend to be expected from a wide application of watershed protection and upstream-control measures.

After consideration of all the basic facts, an inescapable conclusion is that flood control must involve more than the engineering problems incident to controlling large volumes of concentrated water in major streams. It must include the physical and biological problems of watershed protection and land use. Moreover, both upstream and downstream control must encompass the highly complex social and economic considerations incident to the promotion of public welfare. Flood control, in itself, is of no purpose. It must meet the human needs by the protection of life and property and the conservation of natural resources. Flood control benefits directly only those below the areas upon which protective measures are installed. Therefore, the nearer the source of flood water that protective measures are established the greater the number benefited. If we start on the land where the water falls everyone contributes and everyone benefits. It is only with this approach to the solution that flood control can be truly considered as promoting the public welfare.

To summarize, flood-control programs which include watershed protection will:

1. Conserve soil and water on the land for useful purposes.
2. Decrease the frequency of minor floods.
3. Diminish the crests of major floods.
4. Reduce sedimentation in reservoirs.
5. Minimize the silting of stream channels.
6. More nearly fulfill the goal of doing the greatest good for the greatest number.



Type of soil erosion and its fixation, watershed of Brisighella, Faenza, Italy.

WATERSHED CONTROL IN ITALY

By Arthur C. Ringland[1]

THE Flood Control Act approved June 22, 1936 is of historical significance because it recognizes the complementary relations of biology and engineering in flood control. But there is an additional significance of far-reaching implication.

The basic framework for the development of a unified and consistent land policy is provided. Congress has directed that a great number of specifically designated watersheds shall be examined, to determine if measures for the control of run-off and for soil erosion prevention can be economically justified as aids in the amelioration of flood conditions. If measures of this character are to influence flood conditions, there must be the complete coordination of Federal, State, and local agencies within the limits of the watershed. The entire land economy is affected. Thus, a watershed becomes not only a project for flood control but a definitely limited physical compass within which all resources are developed to serve their highest usefulness.

[1] Chairman, Flood Control Coordinating Committee, U. S. Department of Agriculture.

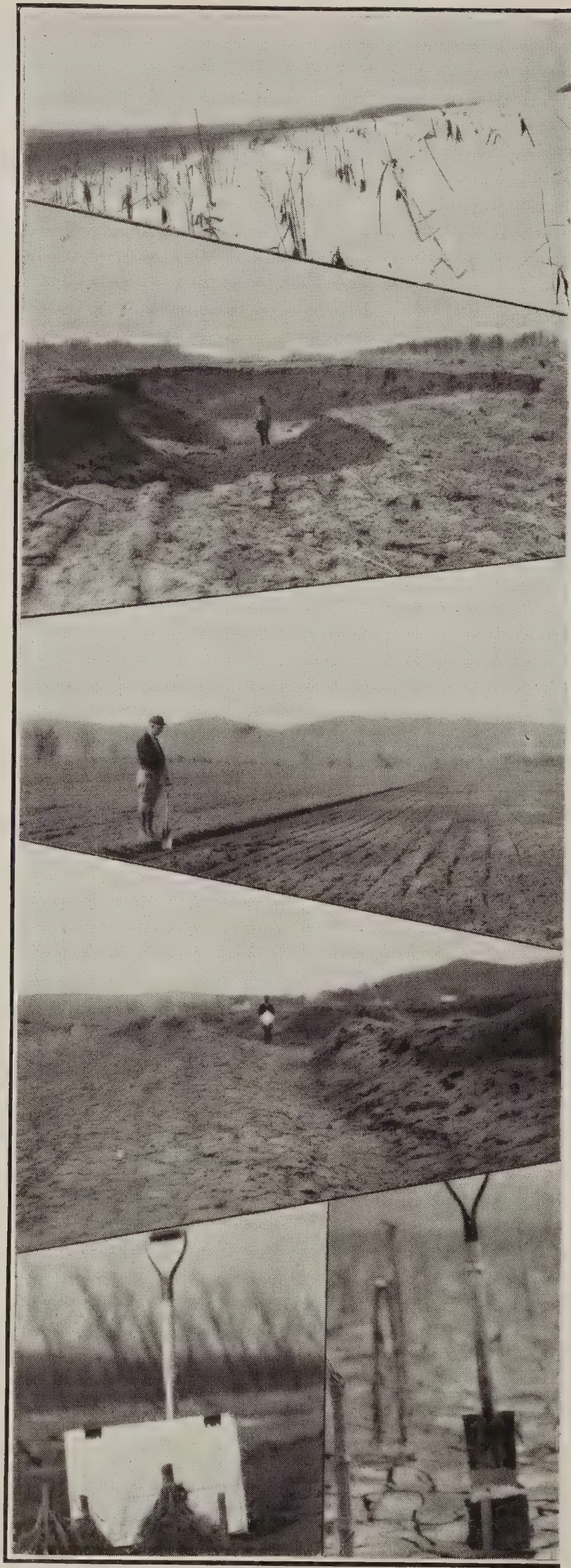
The integration of conservation activities made possible by the Flood Control Act of 1936 has a parallel, interesting if remote, in the Italian national land plan. This plan is based upon the law of Integral Land Reclamation adopted in 1933 and better known as "Bonifica Integrale."

"Bonifica Integrale" has for its objective the stabilization and betterment of rural life in all its aspects. The policy now in effect embraces all measures necessary to promote and stabilize the economic and social usefulness of the land, through the comprehensive development and prudent husbandry of selected areas classified as projects of public interest and utility.

These measures include the following:

1. *Conservation works* in mountain watersheds—prevention of soil erosion through fixation of slopes, and reforestation; correction of streambeds and the control of water flows at their source; improvement and regulation of pasturage; regeneration of deteriorated forests.

(*Continued on p. 265*)



Traveling

ALONG the Ohio River farmers are taking inventory of flood damage and estimating repairs following the greatest flood in the history of the valley. Some are thankful that their houses are not so far off the foundations as to be twisted beyond repair. To be sure, the downstairs walls must be replastered, door frames and window casings repaired, doors and windows replaced, and a new floor laid, but that is much better than having a building wrecked or lying on its side among the willows in the creek. The barn may be intact—or it may be in the neighbor's field, lodged in some grove, or sitting across the road. (One barn in the latter position fortunately had two large doors which could be opened, allowing traffic to proceed "as usual"—through the barn!) The various other outbuildings may be badly damaged or missing. The corn, tobacco, and hay were either ruined or floated away. Most of the livestock is back, safe after a sojourn on the hills, but the chickens which were placed in the barn loft for safekeeping were drowned.

Survey Inception

Losses of this kind can be interpreted rather easily in terms of dollars and cents. On the contrary, effects of the flood upon the fields of Ohio Valley farms are not so easily expressed in figures representing loss or gain. Two general assumptions are usually made in regard to flooded farm land: First, large quantities of soil—presumably from the uplands—will be left on the flooded lands when the waters recede; and second, these deposits are rich in plant food and are a benefit to the land. But was there a valuable deposit left on the valley lands by the recent Ohio flood? Concrete data and not general assumptions are necessary to answer this question.

Late in January, Dr. H. H. Bennett requested the Section of Conservation Surveys and the Section of

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The pictures on these two pages serve as indices of the terrific damage inflicted on buildings and fields by the recent floods—silting and sand depositions, gouging of holes and channels, the removal of good soil from around roots, the accumulation of debris and the wreckage of homes.

Soils

by Mark·H·Brown

An Erosion Surveyor Views The Flood Zone

Sedimentation Studies to investigate the condition of the farm lands and urban areas in the flooded zone from Pittsburgh, Pa., to Cairo, Ill. The Section of Conservation Surveys was designated to study farming areas, and a party from the eastern field survey office began field work at Pittsburgh on February 19. Some delays resulted from frozen or snow-covered ground, and muddy roads checked our progress in certain areas. At times it was necessary to use rowboats and motorboats to reach out-of-the-way places. However, at the present writing (March 28) but a few days of field work remain, and practically all of the observations have been made on areas not yet disturbed by farming operations.

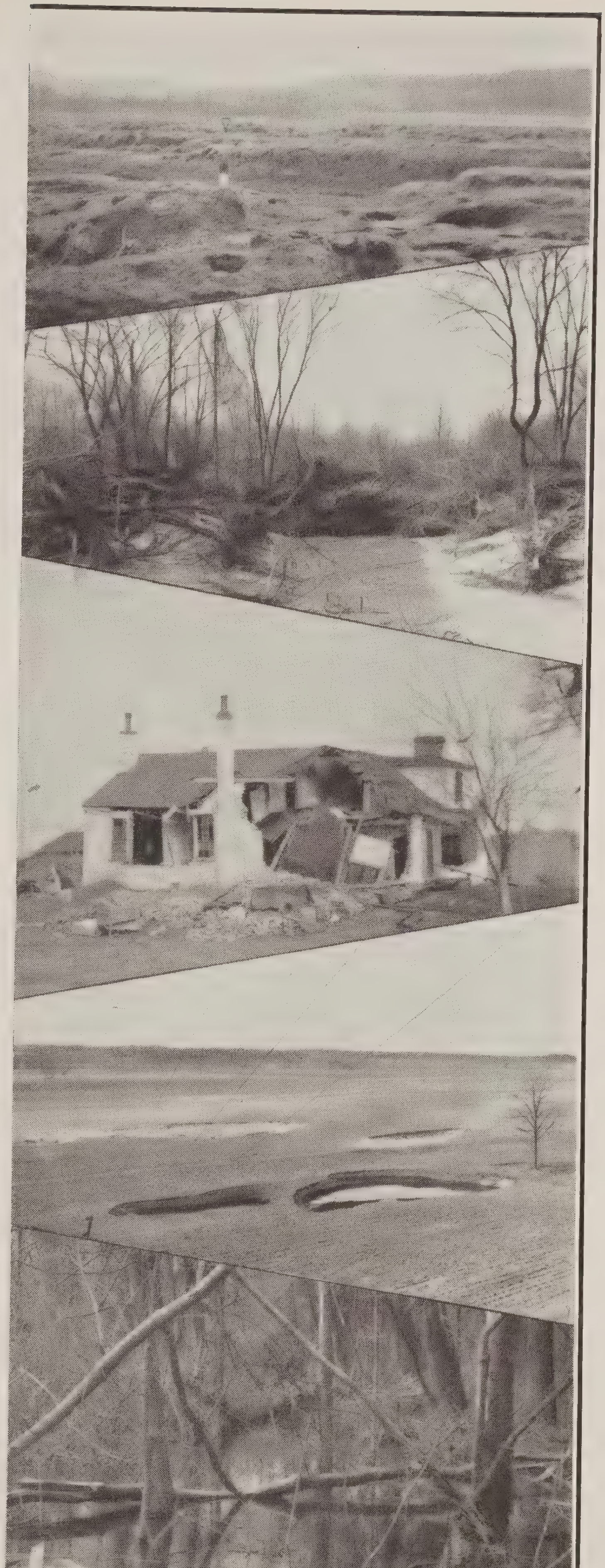
Data Mapped

The general plan has been to survey cross sections of the valley approximately one-half mile wide at 5-mile intervals. Since no previous surveys were available for a guide, the mapping technique was developed by the survey party after a study of the field conditions. Three factors were recorded on the maps:

1. Estimated amount of deposit or removal.
2. Nature of deposits or estimated removals (fine sandy loam, silt, silty clay, etc.).
3. Land use or cover—clean-cultivated, pasture, weedy fields, timber, etc. (These were grouped according to the role each played in deposition or removal.)

Excellent base maps for this work were obtained from the United States Army Engineers. From Pittsburgh to Louisville all data were recorded on Ohio River Charts at a scale of 600 feet to 1 inch. From Louisville to Cairo all areas near the river requiring the mapping of considerable detail were also mapped on these charts, while the wide expanses of valley were mapped on Ohio River Flood Plain Charts on a scale of 2,000 feet to 1 inch. With these maps it was possible to record much detailed information, and to do the work quickly and accurately. In addition to the mapping, samples of deposits were taken for moisture and other analyses, and a careful set of notes was kept of all information not clearly set forth on

(Continued on p. 267)



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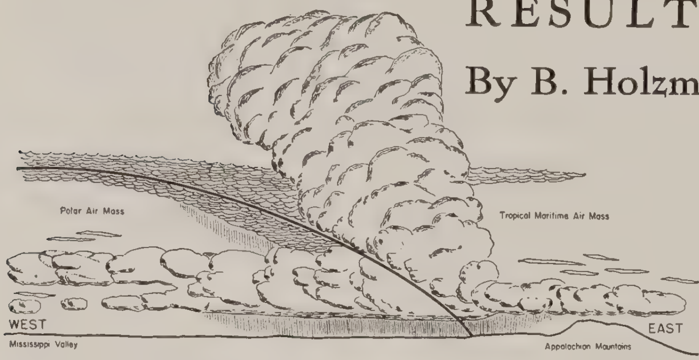
CHANGES IN ATMOSPHERIC CIRCULATION RESULT IN FLOODS



By B. Holzman and K. Clarke-Hafstad [1]

THE FREQUENT occurrence of floods and droughts during the past few years has made everyone acutely conscious of the climate. We know that the climatic elements such as temperature and rainfall of any particular region undergo periodic daily and seasonal variations; but the unexpected aperiodic variations are brought forcefully to our attention because they often result in such national disasters as droughts and floods.

We usually think of a climatic province as characterized by a certain average temperature and precipitation, but these values are derived from a wide range of variations and the average seldom if ever occurs.

The Climatic Province

The variations result fundamentally from significant changes in the general circulation of the atmosphere, which in turn are accompanied by changes in the prevailing trajectories of large bodies of air having great horizontal homogeneity in their physical properties. The boundaries between air masses are called "fronts." The greatest amount of precipitation for the United States occurs at these boundaries, where warm moist air bodies slide up over cold dry air bodies. Thus a climatic province is fundamentally characterized by a certain frequency of invasion of various types of air masses.

Climatic Shifts

In the Northern Hemisphere the distribution of land and water is such that two centers of high atmospheric pressure known as quasistationary anticyclones are maintained in the middle latitudes over the Pacific and Atlantic Oceans. Frequently these circulation centers change in intensity and geographical position, and are accompanied by a shift in meteorological conditions throughout the country which occasions profound climatic changes. The shift in the circulation system is also associated with a change in the prevailing trajectories of air masses. The physical properties of these large atmospheric currents are then modified in response to their altered paths. As a result a period normally expected to be warm and dry may actually be cold and wet.

The excessive precipitation of January 1937 in the Ohio Valley can be explained by a change in the meteorological conditions usually influencing that region. In 1914, Humphreys [2] pointed out that a shift to the west or a westward extension of the Azores quasistationary anticyclone was accompanied by abnormally high temperatures in the eastern United States and by low temperatures in the central and western parts of the country. The temperature departures were in complete coincidence with the meteorological conditions.

Causes of Excessive Precipitation

The atmospheric circulation around the Azores anticyclone is such that when the center of the "high" maintains its normal January position as shown on fig. 1, large quantities of Tropical Marine (Tm) air whose warm, moist properties are acquired over the ocean waters of the Sargasso and Caribbean Seas, are transported northward over the western North Atlantic Ocean. Cold, dry Polar Continental (Pc) air masses, whose origin is over the Arctic tundra of northern Canada, then invade the entire eastern United States and the most vigorous interaction of the two air bodies occurs over the Atlantic Ocean.

With an intensification and westward extension of the Azores anticyclones, as occurred in January 1937, there is a decline in the velocity of the Polar Continental air masses as they proceed south-eastward and the principal zone of contact with the Tropical air occurs over eastern United States instead of at sea. This was indirectly the cause of the abnormally high temperatures of last January in the eastern portion of the United States. The cold, dense air mass served as an invisible barrier to the Tropical Marine air, which ascended aloft along the boundary surface, furnishing

[1] Assistant soil conservationists (Climatic Research), Section of Climatic and Physiographic Research, Soil Conservation Service.

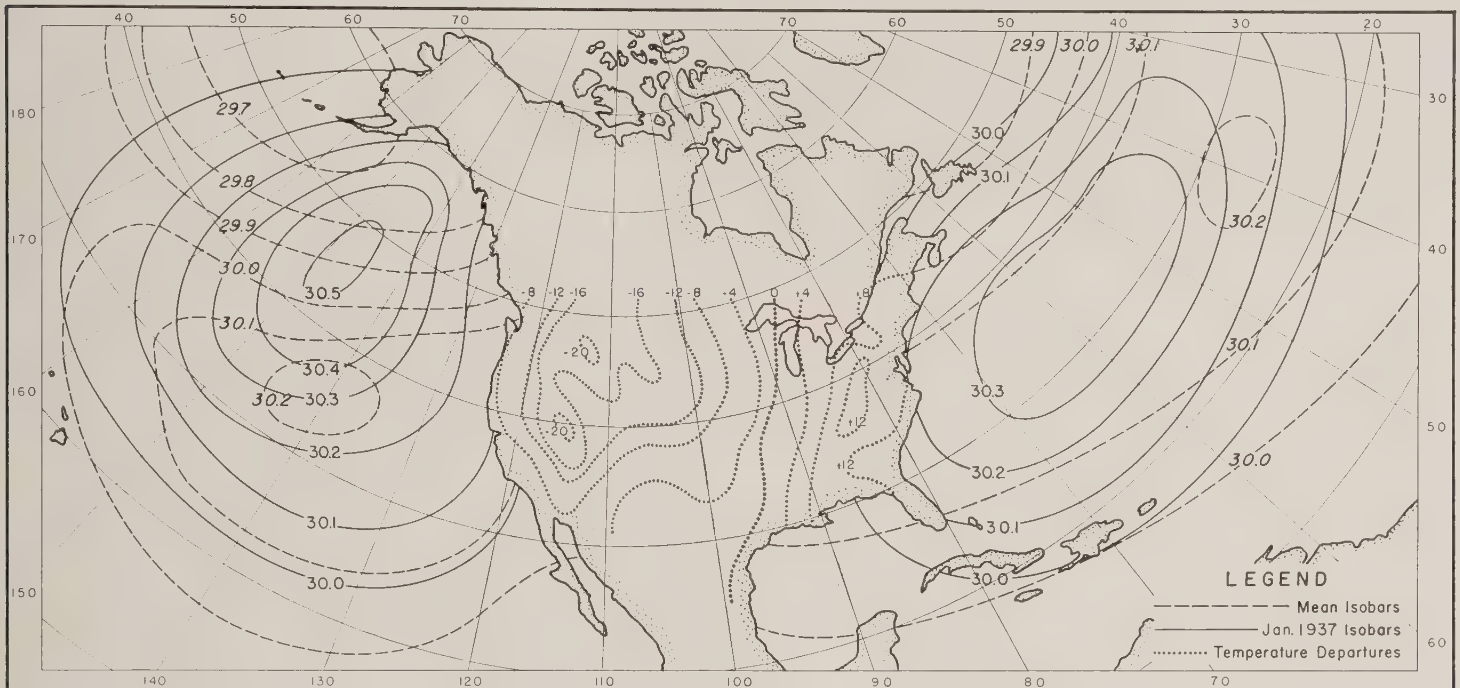
[2] Humphreys, W. J.: Why Some Winters Are Warm and Others Cold in the Eastern United States, Monthly Weather Review, vol. 42, pp. 672–675, December 1914. (35 charts.)

an endless supply of moisture for precipitation as long as these conditions were maintained.

As yet we do not know what relationship exists between the outbreaks of Polar air and the intensity and position of the quasi-stationary anticyclones. The explanation may be discovered by further investigation of the source areas or it may require research concerning disturbances of the stratosphere or variations in solar energy.

Mammoth Cloud Systems

Figure 2 is a diagrammatic cross-section of the atmosphere from west to east across the Appalachians during one of the typical rainstorms that occurred in the Ohio Basin last January. Even though the vertical scale is greatly exaggerated on the diagram, the wedge of cold Polar air is a far more formidable barrier than the the Appalachian Mountains which extend to only



one-third or one-fourth of the height of the air mass. Condensation begins with the formation of alto-stratus clouds from which a steady light precipitation soon falls. As the lower levels of the atmosphere become saturated by the precipitation, lower cloud decks such as stratocumulus and stratus develop and may eventually coalesce into a single cloud system as much as sixteen or seventeen thousand feet in thickness. The resulting rainfall is known as the "warm-front type" and produces an extensive steady uniform pattern that may conceivably be maintained for several days. However, this rainfall pattern may become considerably complicated if the transport aloft of the Tropical Maritime air is sufficiently active. Huge convective currents may be created after a certain critical ascension is attained, and manifest themselves in the form of cumulo-nimbus clouds that may extend to an elevation of thirty to forty thousand feet. Convection generally results in precipitation that is extremely variable in intensity, amount, and distribution, but it is most likely to produce downpours which may cause serious soil erosion. The soil erosion

(Continued on p. 266)

Widespread Rainfall of January

In January 1937 the velocity of the Polar air masses invariably diminished to such an extent that the line of contact with the Tropical air bodies became nearly stationary after reaching and paralleling the western face of the Appalachian chain. This entire frontal zone then, in meteorological terminology, was characterized by "fronto-genesis", meaning that the boundary between Polar and Tropical air currents became more sharply defined. Oscillatory movements were consequently produced along the boundary, and these, as has been shown in detail by the Soil Conservation Service climatic project in Oklahoma,[3] are a controlling influence in the type and intensity of precipitation. Because of the westward extension of the Azores anticyclone in January, the fronto-genetic field paralleled the western Appalachian area and permitted a tremenduos volume of warm, moist Tropical air to ascend aloft over the cold Polar barrier, resulting in widespread rainfall.

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[3] Corwin, Leonard B., Sampling the Weather at the Oklahoma Climatic Research Center, p. 237, April 1937, Soil Conservation.

· PLANNIN
CONS

ALL SOUND PLANNING is based on a definite objective, a comprehensive inventory, an adequate history, and a broad knowledge of applicable controls.

Soil and water conservation is not an end in itself, but a means by which a nation can preserve natural resources, control floods, prevent impairment of reservoirs, maintain the navigability of rivers and harbors, protect public health and public lands—all of which are in the interest of public welfare.

Values—Individual and National

When public funds are being expended, benefit to the individual farmer for whose land plans are being made must be considered as secondary to the public benefits. This should not be construed to mean that the plans for the individual farm should not benefit the operator by aiding in maintenance of his soil and conservation of the rainfall for crop production. In this respect, a benefit accrues to the farmer through the safeguarding of his capital stock, the land, and by making possible the utilization of the land and the conserved water for his personal profit, over a long period of years. In this regard, the long-time benefits to the individual are common to those of the Nation as a whole. The immediate benefits to the individual should be sufficient to convince him of the value to himself and his children of carrying out a program that will attain the desired end.

The Watershed Approach

Because of the broad objectives of soil conservation, the watershed approach has been used by the Service in its demonstrational program. Little can be accomplished toward flood control, prevention of impairment of reservoirs, or maintenance of the navigability of rivers and harbors, if only isolated farms adopt conservation measures. Food waters and silt loads do not stop at farm boundaries, nor at county lines, hence the need for community action on a watershed basis as an

FOR SOIL AND WATER · ·
RVATION

by E. J. Utz

Head, Section of Erosion Control Practices, Soil Conservation Service, Wash., D.C.

additional objective in a program designed to conserve soil and water.

Bearing in mind these broad objectives which can be attained through a soil- and water-conservation program, the planner must turn his attention to an inventory of conditions as they now exist. The fact that Cecil sandy loam is excellent cotton soil does not guarantee that the soil in its present condition is capable of producing an excellent crop of cotton. With the topsoil removed by erosion, this soil drops to the level of inferior soil types for crop production purposes. Even though a portion of the topsoil remains, the topography may be such that continuous use of the land for rowcrop production will eventually cause washing away of the remainder.

In a comprehensive inventory the erodibility of the soil, as well as its normal productive capacity, is important. It follows, therefore, that the extent of erosion, the degree of slope, and the soil type are three significant factors for a physical inventory. A fourth factor, land use, or present vegetative cover, is also important, not only in explaining why present conditions of erosion exist, but also as a starting point in outlining future programs of control. A physical inventory is not the only prerequisite for proper planning on farm and range lands. The ideal erosion-control and water-conservation plan might involve the retirement of large acreages of land from cultivation to forest and permanent grass cover. Such wholesale conversion would leave the farmer with too little cropland from which to produce agricultural products, thus seriously curtailing his income.

The same curtailment of cropland would throw production out of balance with the food and fiber requirements of the Nation, with resulting scarcity and high prices. Consequently, the farm organization must be disturbed as little as possible. In order to determine the requirements for a stable farm organization, an economic inventory must also be made. Both the economic and physical inventory, then, are necessary for planning work.

'roper land use.

evere erosion in orchard.

Basin listing on contour.

Contour strip cropping and terracing.

mproper land use.

The third basic requirement for farm planning is an adequate knowledge of the history of the area to be planned. What crops have been grown on the land, and under what cultural practices has the land arrived at its present condition?

On one farm, where Miami silt loam is the predominating soil type, serious erosion may have taken place because of the continuous cropping to clean-tilled crops, with the rows running up and down the hill. The organic matter content of the soil is very low, with the resultant poor physical condition. On such a soil, the percentage of run-off is large, and the absorption very low.

On an adjoining farm, under similar soil and slope conditions, where an adequate rotation of row crops, grain, and grasses and legumes has been continuously carried out, with the cultivation on the contour, and under a system of strip cropping, practically no soil has been lost. The soil is in good physical condition and absorbs rainwater readily, resulting in a small percentage of run-off. A comparison of the history of these two farms not only explains why the one is seriously eroded, but points out the remedy to be applied in planning a conservation program for the other farm.

period of years it may be brought back to a satisfactory productive state.

Farmers' Discoveries Applied

Most of the practices being advocated in soil-conservation work today are those that have been discovered and applied here and yonder by the best farmers of the Nation. Delving into the history of the various farm units provides the picture as resulting from conservation of our land resources on the one hand, and their exploitation on the other. Research studies have perfected many of these practices found here and there, and pointed the way to their widespread application in other areas.

Often, the application of individual control measures is considered all that is necessary in conservation planning. Such a viewpoint is similar to that of the doctor who prescribes quinine or castor oil for all his patients, on the theory that one of these two remedies will be beneficial in a majority of the cases, or at least seldom harmful. The successful planner, like the successful doctor, must first make a diagnosis of the patient's condition, determine the history of the case, and then prescribe the remedies which will effect a cure. The patient who delays too long in seeing the doctor may not respond to the treatment, and his con-

Wide-row contour planting of milo in preparation for fall wheat planting, in Dalhart Co., Tex. Effective in holding soil until next crop is planted.

tribution to society comes to an end. Likewise, some of our land has been allowed to deteriorate to such an extent that its productive capacity is lost, and it must now be utilized for purposes which are not so intensive as crop or livestock production.

The old adage "An ounce of prevention is worth a pound of cure" is certainly applicable in conservation work. The farm that has been operated without regard for conservation will need the "pound of cure" in the form of additional practices, such as heavy fertilization, utilization of green manure crops, longer rotations, and the like, in order that throughout a

As has been mentioned above, both the broad or long-time and the immediate or restricted objectives must

Orchard with trees planted on contour. Erosion control effected by use of terraces, vegetated strips, and contour operations.

be kept in mind in applying erosion-control measures. In areas where floods and silting are not important considerations, major attention can be given to the conservation of soil and water for crop and livestock production. Here the restricted objectives prevail, and the interests of the operator and the nation closely parallel. Where the control of floods and the reduction of silt is of paramount importance, the interests of the operator, at least the immediate interests, must be secondary to those of the public. In most instances controls in the latter case will need to be more drastic from the point of view of the operator.

A major consideration in planning is the determination of proper land use. Certain soil types, especially under certain slope conditions, are not suitable for the production of cultivated crops unless the operator is content with heavy soil losses. In the same situation, the utilization of this land for pasture or hay crops, where they are kept under adequate vegetative cover, may not only conserve the soil but at the same time return greater profits to the operator. The same soil type, under steeper slope condition, or a different soil type under the same slope condition, may have its most effective use only under forest cover. The farm planner must have a sufficient knowledge of the behavior of different soils under different conditions, in order to plan adequately for proper land use.

Land use, however, is affected by the extent to which it is practical to apply measures of control which will aid in soil and water conservation. Increasing the humus content of soils, using a cropping system which will provide dense vegetative cover on the land during seasons of heaviest rainfall or strongest winds, contour cultivation, terracing, strip cropping, and contour furrowing—these are among the control measures on cropland that may be applied to modify land use. Without the use of one or more of these control measures, certain lands could not safely be cultivated. Furthermore, the application of these controls enables the farmer to use a much larger percentage of his farm land for crop production. Thus the determination of land use and the application of control measures are dependent one upon the other.

The Means to the End

The effectiveness of the various control measures depends upon their relative value in providing protection against the action of water and wind, and in retaining as much rainwater as possible where it falls. Seldom does any individual control measure meet the needs of the situation. Used alone, contour tillage, or terracing, is not sufficiently effective, but a combination of these with adapted rotations, especially when used as contour strip cropping, does provide the necessary protection.

Much has been written and said as to the relative effectiveness of contour cultivation, terracing, strip cropping, rotations, cover crops, and the like, in the conservation of soil and water. Suffice it to say that the ability of the planner to select the proper combination of these control measures to fit the infinite variety of conditions found on farm and ranch, determines success in conserving soil and water, and in attaining the broad objectives of the national program.

FARM MANAGEMENT INFORMATION NEEDED IN FARM PLANNING

By E. H. Reed[1]

THE fundamental basis of the soil-conservation program is wise land use coupled with proper soil-conservation practices, such as contour cultivation, strip cropping, or terracing. Three groups of factors should be considered in farm planning, namely; physical factors, economic factors, and human factors.

Physical Factors

It is generally agreed that physical factors, such as soil type, slope, and degree of erosion, are fundamental and must be taken into account in developing a plan of work for an area or for an individual farm. While these factors can be determined roughly through inspection by the conservationist even though he is not a trained soil scientist, they are considered so important that a detailed conservation survey is deemed desirable to obtain more definite information for use in farm planning.

Economic Factors

The economic factors likewise are fundamental. The farmer should be interested in conserving soil for the use of future generations, and at the same time, he is in the farming business primarily to obtain an income rather than to conserve soil. If the soil-conservation program unnecessarily reduces this income or necessitates considerable additional labor or inconvenience, he will not follow it. Furthermore, if the farm plan is economically unsound and the farmer ceases to follow it, he may feel that the erosion-control practices such as strip cropping or terracing are to blame, whereas the real cause may be a faulty economic set-up. Thus, if the demonstrations are to be effective and the practices spread to other farms, the program must be economically sound and feasible.

In developing a program for an area or for an individual farm, the conservationist sets up both the land use and the methods which are to be followed by cooperators for the next 5 years and which he recommends to be followed generally for a more extended period of time by other farmers similarly situated. This places upon the soil conservationist a great responsibility. He must be sure that his recommendations are economically sound and feasible, both from a short-time and from a long-time standpoint. It is probable that in many instances in the past, insufficient attention and study have been devoted to these economic aspects.

How may the conservationist determine whether the proposed program is economically sound? The physical factors can be seen, while the economic factors must be discovered through study. It is therefore essential that certain farm-management data be obtained and carefully analyzed previous to planning the program for an area or for the individual farm.

The economic feasibility of shifts which are desirable from the standpoint of soil conservation should be considered. Probably the easiest method of reducing erosion on sloping land is to remove this land from clean-cultivated crops and place it in close-growing crops such as hay or pasture or to shift from row crops, as corn or cotton, to close-growing crops such as small grains. To what extent will the farmer be able to utilize these products, either for feed or for sale as cash crops? What effect will such shifts have on his farm income?

In many instances it may be desirable to make less marked changes in type of farming, and more radical changes in methods of farming, such as the adoption of contour cultivation, strip cropping, or terracing. In most regions, especially in the older areas in the eastern half of the United States, the present type of farming is the result of long years of experience, determined largely by the method of trial and error. In such areas, there are ordinarily some fundamental economic reasons for the present type of farming, and in these areas radical changes might lead to serious consequences. On the other hand, in some of the newer sections of the country, marked changes in type of farming have taken place in recent years, and it may be that still others are desirable. The conservationist should not be averse to changes in type of farming, but before such adjustments are recommended, he should be sure that they are economically sound, and that the farmer can adjust his operations accordingly.

The human factors must also be considered—the farmer's training, experience, and ability. He may have acquired certain knowledge and skill in handling particular enterprises, while he may know but little about others. Again, his likes, dislikes, and aptitudes

[1] Head, Farm Management Unit, Section of Erosion Control Practices, Soil Conservation Service, Washington, D. C.

must be considered. The cash-crop farmer may not like a year-round job such as livestock production, or the hog farmer may be averse to milking cows. A program which involves marked changes may cause him to refuse to follow soil-conservation practices.

The consideration of these important, and at the same time somewhat intangible, economic, and human factors should not dampen the soil-conservationist's ardor for desirable changes in either land use or methods. It is agreed that in the interests of both private and public welfare, something must be done to prevent the present rate of erosion. However, recommendations for physical changes should be made only after careful study of the economic and human factors, and after it has been determined that the program is sound in all aspects. If this is done, we may feel confident of a spread in recommended practices.

Needs for Farm-Management Information

In the consideration of economic factors, certain farm-management data are necessary. The use to which the information is to be put will, to a considerable extent, determine the kind of data which should be obtained. This information is needed for three specific purposes in farm planning; first, to help determine the plan of work for the area; second, to fit this general plan to the needs of the individual farm; and, third, to study the effects of the application of the plan to the individual farm, and to determine what, if any, changes are needed in the plan.

Plan of Work for the Area

Farm-management, as well as conservation surveys, should be made in a newly designated demonstration area, to serve as basic information for the plan of work. The farm-management data are essential in determining the economic soundness and feasibility of the changes in land use or methods which are shown by the conservation surveys to be worth while. Such data may be obtained by the making of farm-management surveys on a well-selected sample, consisting of from 15 to 25 percent of the farms in the area. The farms surveyed should be representative of the type of farming, size of farm, soil type, topography, and quality of farming.

This survey should be a complete income survey showing land use, the acreage and yield of various crops, the kinds and amounts of livestock, the amount and value of crop and livestock sales, the amount of products furnished by the farm for the family living, and the various items of expense. These data should be completely summarized and analyzed so as to show the incomes, the factors affecting incomes, and the strong and weak places in the present methods of farming. In analyzing this information, it may be well to compare the organization and methods used on farms obtaining high returns with those of farms obtaining low returns.

In order to determine the correlation of the physical and economic factors, the data obtained from the farm-management survey should be studied in connection with those obtained from the conservation survey. Changes suggested by the need for soil conservation should be carefully studied so that they may be made to fit in with the farm-management program. Likewise, the changes desirable from the farm-management standpoint should be studied as to their soil-conservation implications. Data which show only the static picture of the present farm organization are of comparatively little value. They should be so analyzed as to show what changes are required. If the plan of work is developed with the aid of this kind of information, it should result in a program which is sound and feasible from the standpoints of both soil conservation and farm management.

Plan for the Individual Farm

Inasmuch as not all farms in an area are identical, the general plan of work for the area will not fit all farms. It is therefore essential that certain information be obtained on each farm before planning begins. For those farms included in the sample of the area, this information will already have been obtained. On individual farms such data should include the kind and amount of livestock, the feed which has been available for this livestock, the amounts of feed purchased, and the acreage, yield, and sales of principal cash crops. With this reconnaissance data at hand, it is possible to determine those changes which should be made to correspond with the livestock feed needs of the farm. After the tentative plan for the farm is developed, a check should be made to determine to what extent the needs have been met, and if necessary the plan should be revised. A study should also be made of the net income possibilities under the new plan as compared with the old.

Determine Need for Change

Even though all information is available when the farm is planned, it may be impossible to develop a plan which fully meets the needs or to get the farmer to

(Continued on p. 266)

Production can be maintained, Farm organizations properly balanced, Soil conserved by careful planning.

THE APPLICATION of FARM MANAGEMENT DATA in FARM PLANNING

By Melville H. Cohee[1]

FROM the physical point of view alone it is entirely possible that a group of properly selected scientists can draft the ideal soil- and moisture-conservation program for a specific tract of land. Because of the social demands made upon that same tract of land, however, it is mandatory that when designing programs the economic aspects of land-use methods and practices be given parallel attention with the physical facts.

Point of First Consideration

It is recognized that in the past many different types of conservation programs failed to attain success because it was impossible to secure proper consideration or development of the economic phases of either proposed or established plans. For example, history tells us that during the last half of the nineteenth century a definite effort was made to establish a long-time forestry-conservation program in the United States. But despite the fact that the leaders recognized the economic phase of the program, it suffered from a lack of cooperation on the part of land owners who had a vision far shorter than that of the leaders. Consequently, complete adoption of this particular conservation program was delayed.

An appraisal of the type of farming, with adequate attention to the land use and individual farm organization, is definitely necessary in a study to determine a soil- and moisture-conservation control program for any area. Before starting work in an area, an over-all plan should be drafted and all parts properly coordinated so that it will serve as a guide to those who work out the plans for individual farms.

Given such factual information as is available from a physical and economic review of existing conditions in an area, the physical scientists and economists become fortified to draft project working plans which should be lacking in no phase. Neither type of information alone will furnish an adequate basis for recommendation, but both types should be analyzed in the light of their historical background.

From Project Plans to Individual Farms

Each individual farm offers a challenge—this because the complicated problems involved are peculiar to the farm. The conservationist who is planning a program of soil and moisture conservation for the individual farm will be confronted with a task of a twofold nature; first, he must determine the individual problems as they are like and unlike those covered by the project working plans; and secondly, he must

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apply correctly the general plans, as previously decided to be desirable for the area, to the individual farm.

It is only as general recommendations are applied to individual farms, which may be operated according to different organizations, that the project working plans become effective for the area. Consequently, it is essential that any agency offering aid to farmers desirous of reducing soil and moisture losses should have at hand a general plan which is sufficiently flexible to permit application to individual farms. Furthermore, because of this method of approach, it should be expected that farms with almost identical physical conditions might require programs differing in the solution of their individual problems.

Balancing the Farm Organization

Farms operated almost entirely for cash-crop sales do not offer the number of opportunities for combination of enterprises as do live-stock farms. For the cash-crop farms the changes in land use and methods of farming warrant direct consideration of input and output. However, for the livestock farm the possibility of balancing varying amounts of feeds and pasture supplies against different numbers and types of livestock does allow for wider consideration of several possibilities of cropping programs and methods.

For the type of farming where livestock enterprises are a part of the organization, and to which this discussion will be confined, it is very easy to disrupt a farm organization by introduction of practices and methods directed toward soil and moisture conservation. To illustrate use of farm-management information in planning a conservation program, the John Brown farm may be used.

The Individual Farm

This farmer had 6 horses and 1 colt, 8 dairy cows and 4 one-year-old heifers, 6 brood sows and 36 young pigs, a flock of 100 laying hens and 200 pullets and cockerels. To meet the feed demands of this livestock and poultry the farmer had the following crop distribution: Alfalfa, 7 acres; clover and timothy, 20 acres for hay and 10 acres for pasture; timothy and bluegrass hay, 8 acres; oats, 15 acres; barley, 20 acres; corn, 50 acres; open permanent pasture, 25 acres. Using standard feed requirements for the above livestock, the farmer needs approximately 1,192 bushels of corn or its feed equivalent in grain, 36 tons of hay and 41 acres of pasture of good to medium quality. Mr. Brown's crop acreage with average yields for the area will allow production of 3,203 bushels of corn or its grain equivalent, 48 tons of hay, and 35 acres of good to medium pasture.

From a purely farm-management point of view, it would seem that this farmer is understocked in all respects except for pasture, while from a soil-conservation point of view it is known that his crop yields are decreasing and that he is rapidly losing his soil because of erosion. The farmer realizes that despite the fact that he does well with his livestock, his entire farm organization is not bringing such returns as he realized a few years ago.

Changes

The soil- and moisture-conservation project working plans, for the area in which Mr. Brown's farm is located, call for reduction in clean-tilled crops and retirement of the badly eroded and steeper areas to permanent pasture. The first application of the plans to this particular farm resulted in plans for retirement of 10 acres of cropland to permanent pasture. To improve the farm organization, the 8 acres of old hay land which are unsuitable for clean-tilled crops will be retired to pasture. This will increase the permanent pasture area to 43 acres. The remaining cropland area will be devoted to the following crops with a 3-year and 4-year rotation, except for the alfalfa area which will be a 6-year rotation: Alfalfa, 15 acres; clover and timothy, 30 acres; oats, 20 acres; barley, 20 acres; corn, 35 acres. The clover and timothy hay land will be used approximately half for hay and half for pasture. The operations to be carried out on the cropland are planned in accordance with good conservation practices such as contour tillage, strip cropping, buffer strips, sodded draws, etc.

The farmer desires to increase his numbers of livestock and will have 6 horses and 2 colts, 10 dairy cows and 6 heifers, 7 sows with 2 litters annually rather than 1, and 100 laying hens and 200 young chickens. With these numbers in the different livestock enterprises, the annual feed requirements will call for approximately 2,000 bushels of corn or its grain equivalent, 44 tons of hay, and 56 acres of good to medium pasture. To meet these requirements and assuming no increase of yields per acre with the planned cropping program, the farmer should produce 2,545 bushels of corn or its grain equivalent, 53 tons of hay, and 58 acres of good to medium pasture.

From a consideration of land use, crop-production data, and the livestock feed requirement data, it is evident that the farmer has made plans to meet the

two most important needs. First, he has made shifts in his land-use program to meet soil-conservation requirements for his farm. Second, he has planned his farm-management program to meet those changes. He will have a better balanced organization than he had before, with possibilities of making the best use of his own time and that of hired labor throughout the entire year.

It is true that from consideration of only the physical factors of the farm such as degree of erosion, slope, and soil type, recommendations could justifiably be made whereby the farmer would retire 25 acres of cropland to permanent pasture and reduce his corn and grain acerage to 60 acres. On the other hand, it is inadvisable from a farm-organization standpoint to reduce his grain acreage further, as this would demand a compensating increase in his hay acreage. With the planned program he will have a small surplus of hay and likewise he will have extra grain. These surpluses will allow expansion of his livestock program, preferably to either more hogs or a few feeder cattle, since his pasture supply is not adequate to care for added numbers of livestock which ordinarily use an appreciable acreage of pasture during the summer months.

Plans Should be Justifiable

Summary and analysis of farm-management data for two farms is presented in the table. Insofar as present information regarding erosion control is available the land-use and cropping rotation programs planned for these farms are suitable for reducing the soil and moisture losses to a minimum. If the proposed plans were slightly different, however, an equal amount of control could be rendered from a physical standpoint, and at the same time permit better organizations.

Feed	Farm 1			Farm 2		
	Hay (tons)	Grain (bushels)	Pasture (animal units)	Hay (tons)	Grain (bushels)	Pasture (animal units)
Available, 1934	33	988	150	26	563	65
Required, average 1935–39	51	1,030	125	23	353	55
Estimated production.						
1935	50	1,199	113	34	554	43
1936	85	808	104	30	784	43
1937	111	441	104	30	711	43
1938	129	588	89	41	396	43
1939	122	665	89	41	651	43

NOTE.—Farm 1: $50 worth of grain was purchased in 1934. The plans call for too much hay and inconsistent amounts of grain and pasture, mostly inadequate to meet requirements. Farm 2: The plans call for more grain than needed and the amounts produced in different years are too variable for best farm-management planning. Too much hay will be produced but the pasture supply will be inadequate.

Supplemental information available to the conservationist shows that farm 1, as indicated in the table, has hay growing on A- and B-slope fields for a period of 4 or 5 years, and then it is broken for corn and grain followed by a seeding to hay. It is also known that these areas are well drained and suitable for shorter rotations. Plans could have been made to include part of this hay land in shorter rotations, which would have balanced the grain production against feed requirements and permitted rotation plans of such a nature that the irregularity of total grain production could be eliminated. Also the farm-management data indicates that there will be a shortage on pasture and an oversupply of hay. Therefore, by cropping some of the meadow and pasturing some other parts of it, the total hay production for the farm could be reduced and the grain and pasture supplies could be balanced with livestock requirements.

As planned by the conservationist, farm 2 will have irregular grain production over the period 1935 to 1939. It is likewise evident that the hay production will be too great and the pasture supply too low for the livestock needs. The conservationist overlooked also the possibility of removing a fence on some B-slope land. This would have allowed redistribution of field acreages and in turn a more balanced acreage resulting in consistent production of different feeds. No plans were made for pasture improvement, but fortunately it is possible to add considerable production by proper treatment of the area. If these changes were made on the farm, the farmer undoubtedly would experience appreciably increased returns in addition to those possible from the present plans. The increased returns would in all probability more than compensate for the necessary costs of the added treatments.

It is recognized that a soil-conservation program must be justified on a long-time basis, and from either the private or public standpoint. The farmer probably will not go through with the academic process involving careful calculation of feed requirements over a period of years and balancing of this process against crop, range or pasture acreage and anticipated yields and carrying capacities. On the other hand, if the planned land-use program fails to fit one of the various profitable organizations which are possible for his farm the farmer will discover this fact as a result of trial and error procedure. One task ascribed to the conservationist is to see that the soil- and moisture-conservation plans are sound from a farm-management and organization standpoint.

(*Continued from p. 251*)

2. *Reclamation works* on the plains and in the foothills—flood control, water storage, drainage, and irrigation.

3. *Improvement works* for the intensive development of agriculture—provision of roads, water supply, electric power plants and transmission lines, erection or reconstruction of rural villages and farm buildings, improvement of agricultural methods through education demonstration, the promotion or rehabilitation of land settlement.

4. *Sanitation works*, principally for the suppression of malaria.

Collectively, these measures are designed to increase employment, expand purchasing power, and add to the national income; settle on the land surplus industrial labor and migratory agricultural labor; intensify and stabilize the production of agricultural, forage, and forestry crops on appropriate soils; withdraw from cultivation or pasturage inappropriate soils; utilize water resources for electric power, irrigation and navigation; prevent soil erosion and floods; rehabilitate and modernize rural centers; promote health; and through example provide education in improved methods of farming.

"Bonifica Integrale" embraces several cardinal principles:

1. The integration of the services which contribute to the organization and execution of the work.

All services in the Government departments which were connected with land development in one way or another have now been coordinated or transferred to the Ministry of Agriculture and Forests and placed under a special Under Secretary of State for Land Reclamation. This was done to secure the most effective collaboration and coordination between engineering, agriculture, and forestry—to secure unity of conception as well as unity of execution.

These specialized branches are supported by cooperative agencies such as the Department of Public Health and the Commission for Internal Migration and Colonization—the first for the work of malaria control and the second for the adjustment and settlement on the land of surplus and migratory labor.

2. The integral character of the execution of the work in the field.

Past work was largely directed to flood control in the lower courses of rivers or simply to the drainage of marsh areas. This work was unproductive and did not fulfill the ultimate purpose of the settlement and cultivation of the land. The direct relation between the devasting effects of mountain waters and the consequent disturbance of the water regime on the plain was ignored. In Italy at present improvement work in the mountain area is considered to be a necessary preliminary condition for improvement work on the lowlands. In any case it is now an accepted principle that these two classes of work must be carried out in close relation with one another.

All work of whatever character is undertaken as a unit operation within a definite area—the conservation works in the mountain watersheds (reforestation and soil erosion control), the reclamation and flood control of the plains, the improvement works for intensive cultivation and settlement and finally the work of malaria control, proceed concurrently. No project is independent or localized.

Under present policies areas are classified by the Minister of Agriculture and Forests, in agreement with the Ministers of Finance and Public Works after a special technical committee of agronomists, foresters and engineers, acting through the Under Secretary of State for Land Reclamation, has expressed an opinion.

The selected areas are those where in the public interest it is desirable to undertake integral measures of conservation, reclamation, improvement, and rehabilitation. The character of the work to be done and its degree of importance as a public utility determines its classification and category (priority), and hence the measures and extent of State cooperation and aid and the type of organization necessary to accomplish the objectives of the plan.

Projects of the first category (priority) are those which have an exceptional importance in the public interest, and which require expenditures too great to be undertaken by private enterprise alone. They are generally taken in regions where for serious physical or social causes the national resources of the soils and waters are wasting or are unproductive, or where life and property are endangered by recurrent floods and landslides or by the presence of malaria breeding conditions.

For each classified area a general plan must be drawn up and approved by the Under Secretary if the project is to be executed with the assistance of the State. This plan will include the fundamental principles requisite to carry out the purpose of reclamation and to assure the utilization of the potential resources of the area.

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ATMOSPHERIC CIRCULATION

(Continued from p. 255)

hazard is, of course, increased many fold if this sporadic rainfall pattern is superimposed upon a soil well saturated from existing warm-front precipitation. Not only is there greater run-off but mass movements of the soil by downhill creep and by slumps and other forms of slippage is promoted.

The previous maximum flood stage of the Ohio at Cincinnati in February 1884 and the Dayton flood of March 1913 occurred as shown by Humphreys' charts [4] when there was a westward displacement of the Azores anticyclone and abnormally high temperatures in the eastern United States.

It is of interest to note that the westward shift in the Azores anticyclone was accompanied by a displacement to the north and west of the Pacific anticyclone. This is shown on figure 1. This shift was correlated with a weakened pressure field over the southwestern United States which permitted frequent invasions of Polar Continental air masses into the Rocky Mountain and Pacific coast regions, accounting for the abnormally low January temperatures.

[4] Humphreys, W. J.: local citation.

The episodic fluctuations in climate are those which most concern us, for it is the extreme variations which bring about the unanticipated flood and drought hazards. An excess or deficiency in precipitation for any one area must necessarily bear a direct relationship to the change in the meteorological conditions usually prevailing in the region, and it is obviously futile to attempt to determine the critical limits of drought or flood conditions for an area without regard to the genesis of complete storms. A study of 50 or even 100 years of climatological data from various stations sparsely scattered about various watersheds may yield no indication whatsoever as to the climatic extremes that may develop from the active meteorological forces if all were simultaneously called into play.

The province of climatology in soil conservation is necessarily one of enlightenment. The climatologist must recognize and inform others of the climatic risks and hazards. Human endeavor can anticipate and prepare for the extreme conditions which produce floods and thereby lessen their ravages, but we do not expect to prevent their occurrence.

FARM MANAGEMENT INFORMATION NEEDED

(Continued from p. 261)

adopt it in its entirety. Additional studies should be carried through from time to time to see how the plan is fitting in with the needs and what additional changes should be made. This information could be obtained either by repeat surveys, or by farm-account records. Since the farmer is more willing to make changes based upon data which he himself helped to compile, it seems advisable that as many cooperators as possible be encouraged and assisted in keeping farm-account records. It is advantageous, wherever possible, that this farm-account work be carried on in cooperation with the college of agriculture, since in most States the colleges already have well-developed programs in farm-account work. These additional records will add to their program, and the extension specialists can be of considerable assistance to the Soil Conservation Service in helping to summarize and analyze these data, and in planning an economically sound program.

AGRICULTURE'S NEW APPROACH

(Continued from p. 246)

The bureaus will carry the technical load and, as explained, the preliminary examinations, at least, will be carried on in the field by their representatives working as committees. This type of cooperation is new to the Department and is being watched with a great deal of interest. To date there is every evidence that it will succeed and that it will open the door to a broader, more comprehensive method of departmental approach in many fields.

WATERSHED CONTROL IN ITALY

(Continued from p. 265)

3. Encouragement of private enterprise in cooperation with the State.

The Government's services are supported by auxiliary reclamation, veteran, and farmer agencies.

Landowners are organized into more than 1,000 associations ("consortia") for the development, execution, management, and upkeep of projects. These associations have the legal character and function of public utility corporations.

(*Continued from p. 253*)

the maps. From time to time the surveyors checked their observations with the impressions of the residents. Sometimes the farmers had observed accurately and thoroughly, and sometimes their ideas were completely erroneous as far as this disaster was concerned. It would have been interesting to know how this flood compared with others which they have experienced.

Analyses To Follow

As previously intimated, all effort thus far expended has been concerned with the securing of survey data before the farmers disturbed the soil. No time has been available to study the 200 (approximately) cross-section surveys which have been made; and in order to prepare a reliable summary of the work it will be necessary to measure the maps, make moisture determinations on the samples, calculate the probable total deposits and removals for the unmapped areas, and to summarize these data for the various sections of the valley. While no definite statements can be made at present about the findings of this survey, a few general comments based on field observations can be offered.

The Flooded Zone

As a basis for understanding the following comments, a few facts about the flooded zone in the valley itself are necessary. Above Point Pleasant, W. Va., the flooded zone was less than that of the 1913 flood, and beyond this point it was greater than that of all known floods. In general, the flooded zone increased gradually in width from Pittsburgh to Cairo. In the upper part of the valley the distance from the river bank to the edge of the flooded area rarely exceeded one-fourth mile in width, while below Owensboro, Ky., this zone at times exceeded 5 miles in width. Three important exceptions occur—one between Cincinnati and Louisville and two between the latter city and Owensboro. In these locations the Valley of the Ohio narrows until it assumes almost a gorgelike aspect, and the conditions encountered in the flooded area here differ materially from those just above and below. Another fact of interest is that practically all the farms in the valley were affected in some way. As the river was the important highway at the time the area was settled, practically all property lines run at right angles to the river bank. Consequently, each farm has a "river front" and extends back to the base of the hills.

The flood plain along the 983 miles of river may be divided roughly into three parts. The valley from Pittsburgh to Cincinnati constitutes one division and is characterized chiefly by moderate deposits and removals, with the area affected rarely extending over one-fourth mile from the river bank. While many of these removals and deposits were often probably only ½ to 1 inch in depth, their effect, combined with that of the water coverage, usually resulted in ruin for winter wheat and alfalfa seedings. No appreciable deposits were found near the upland unless there was a swale or depression leading down from the main channel. This condition was general throughout the valley, and in no instance did the writer observe more than a trace of deposit in an area filled by backwater from the river. In fact, were it not for the telltale line of trash left at the high-water mark, it would be impossible to tell that most of these areas had been flooded. This and other supporting observations lead to the conclusion that the main silt load was carried in the zone of strongest current, and that this zone followed the regular channel.

Deposits on Wide Flood Plains

Another part of the flood zone having distinct characteristics is the area of wide flood plains which occurs below Cincinnati. In this part, with the exception of a zone on either bank of the river about one-fourth mile wide and parallel to the channel, deposits were usually found only where trees and brush checked the rate of flow. As these occurred chiefly in swampy areas, little deposit was left on the cultivated land. These deposits rarely exceeded ⅜ to ½ inch in depth (dry basis). Different conditions were found in the vicinity of the two large bends near Evansville, Ind. These bends lay in a location apparently subject to unusual current conditions, and uniform deposits of ½ to 2½ inches of silt and silty clay were found over appreciable areas in this part of the valley.

Bottom Land Soils

Soil survey maps of scattered areas along the Ohio River show that in general the bottom land soils are silty in nature, with silt loams predominating. Relatively small areas confined to back bottoms are silty clay, and narrow strips along stream edge are in places sandy. Many of the deposits of sand in the recent flood were laid down upon silty soils, and where de-

(*Continued on following page.*)

THE FUTURE OF THE GREAT PLAINS, a publication of the Great Plains Committee, will be reviewed in this department in June. Curtailed space requires its omission from this issue.

(*Continued from preceding page.*)

posits of sand are deep, some of the best soils of the valley have been ruined for agricultural purposes. Silt deposits may be considered an advantage rather than a detriment, as deposition is the natural process by which such bottom land soils are formed.

The deposition of silty material was greatest in pockets of the bottoms where eddies formed, and in estuaries of the lateral tributary streams in the regions where the streams carried a heavy load of sediments.

Gouging

As would be expected, the gorgelike areas of valley—the third division—showed evidences of bank cutting and hole "gouging", usually associated with sand coverage. Drifts of medium sand 6 to 7 feet in depth have been observed in some localities, and areas as much as 250 yards wide were sometimes covered to an average depth of 6 to 10 inches. Such areas are hopelessly ruined unless a future flood removes the sand. In general it might be said that the entire area from Cincinnati to Cairo has an appreciable amount of sand coverage. The sandy deposits occur along the stream edge of the bottoms. In most cases this presents a serious problem, as a sand drift has no greater agricultural possibilities in the Ohio Valley than on the Great Plains.

Removal of soil from fields by cutting action of flood waters has occurred in numerous places throughout the entire flooded area of the Ohio River, but is more pronounced between Cincinnati and Cairo. There has been little gouging except where flood waters made short cuts across bends. These areas, although spectacular in appearance and devastating to the land where they occur, are confined to comparatively small areas. Sheet cutting in general is widespread, consisting of the removal of ½ to 6 inches of the surface soil from entire fields, while in places near the streams cutting has sometimes been as much as 1 to 2 feet deep. These areas are usually found where the flood waters were constricted in rather narrow bottoms and reached a depth of 30 to 50 feet or more.

The most severe and widespread damage of this kind occurred upon plowed fields, corn stubble, and soybean stubble, whereas alfalfa, grasses, or even a cover of weeds furnished remarkably good protection. On some of the more exposed positions close to the main channel where the river was straight, or where the water had a tendency to cut across bends, even the best cover was not sufficient to prevent cutting. As corn is the leading crop of the valley, it may be readily seen that much of the land was in prime condition for cutting, and to this fact alone is due much of the loss sustained upon farm lands.

In addition to the silt, clay, and sand deposits, the entire valley, particularly from Portsmouth to Cairo, is littered with drifts of trash. These vary in composition from cornstalks and whisky barrels in one area to brush, logs, and wrecked buildings in others. They occur in fence corners, groves, drainageways, and even in open fields, and cover areas from 1 or 2 rods square to 2 or 3 acres. At present they constitute a very noticeable feature of the area, and one of considerable annoyance to the farmer. However, given some dry weather, a match and some kerosene will eliminate this problem.

Tributary Valleys

Uniform deposits of silt, rarely exceeding 2 to 3 inches in depth, were noted in the valleys of some of the tributaries. However, these deposits did not extend more than a few miles above the mouth, and no important deposits were noted on the south or east sides of the Ohio River. The valley of the Kanawha River, for example, had no trace of deposit above its mouth, whereas the Miami, Scioto, and other rivers in Ohio contained silt deposits at their mouths. To date, no survey has been made on the mouth of the Wabash River.

The above observations relate only to the outstanding, easily noted effects of the flood. What it actually meant in tons of soil deposited or removed from alluvial lands, acres of land altered or destroyed, and a number of other things can be estimated only after the field data have been analyzed. Unfortunately the preflood conditions can only be estimated by approximation. It is hoped, however, that the final analysis will bring to light a number of interesting facts as yet unsuspected.

U. S. GOVERNMENT PRINTING OFFICE: 1937

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RESCHEDULED FOR JUNE

As we near the end of Volume II and approach the beginning of Volume III, we find it necessary because of space limitations to postpone the publication of a number of timely and practical articles.

Among the papers originally intended for this issue which must be reserved for June or later is C. L. Hamilton's pointed discussion of the recent orchard conference in Washington.

Other contributions now in type, which will appear in an early issue, include Range Improvement by Water Spreading, by A. T. Semple and B. W. Allred; Soil Conservation and the Civilian Conservation Corps, by J. G. Lindley; On Opposite Sides of an Old Soil Fence, by Helen M. Strong; and Some Cracking Big Gullies, by Wellington Brink.

SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. SOIL CONSERVATION seeks to supply to workers and cooperators of the Department of Agriculture engaged in soil conservation activities, information of especial help to them in the performance of their duties, and is issued to them free by law. Others may obtain copies from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic. Postage stamps will not be accepted in payment.

WELLINGTON BRINK EDITOR

WHAT FARM PLANNING MEANS—AT A GLANC

SOIL CONSERVATION

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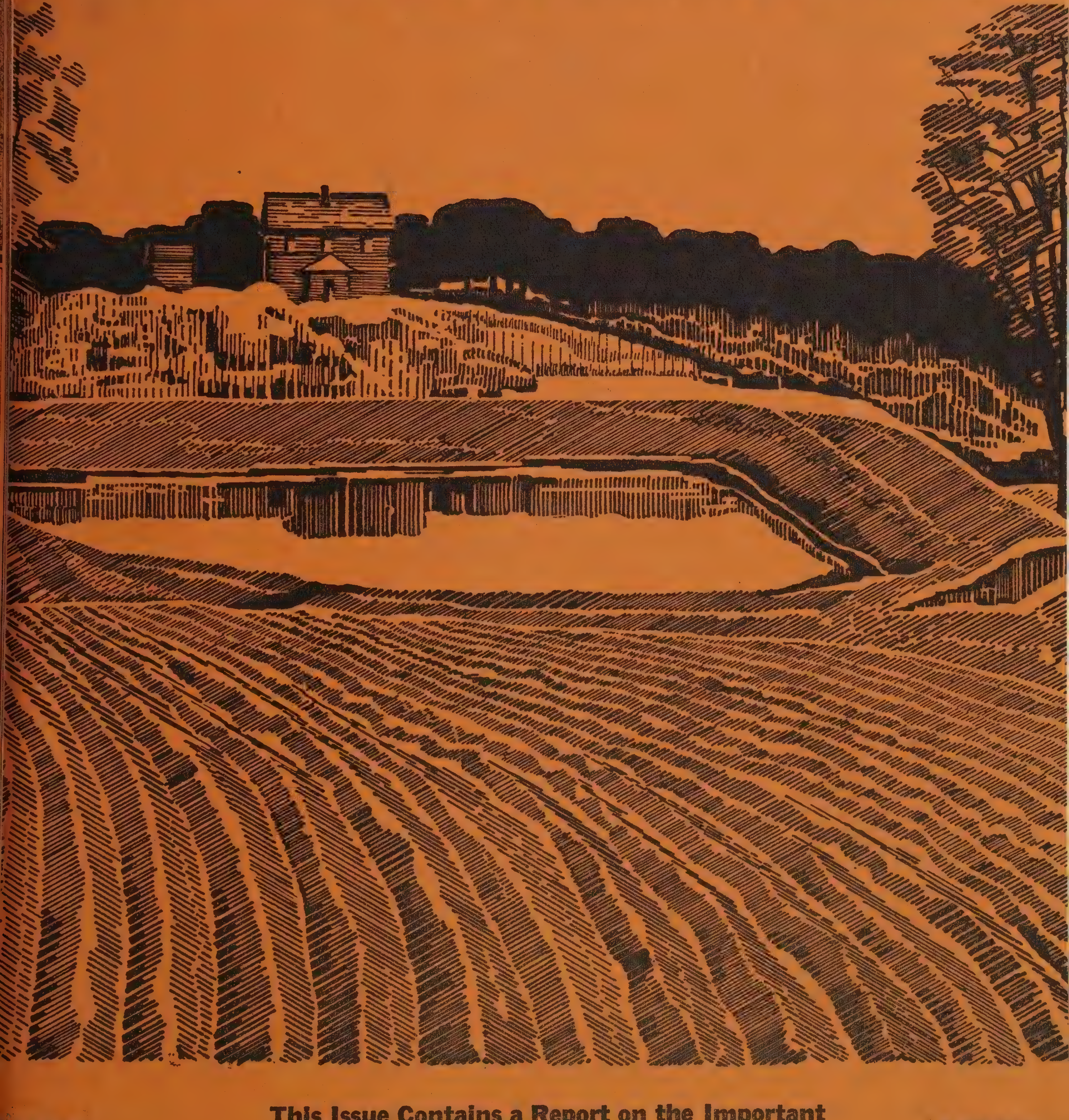

JUNE

This Issue Contains a Report on the Important Orchard Conference

1937

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SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. SOIL CONSERVATION seeks to supply to workers and cooperators of the Department of Agriculture engaged in soil conservation activities, information of especial help to them in the performance of their duties, and is issued to them free by law. Others may obtain copies from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.40, foreign. Postage stamps will not be accepted in payment.

WELLINGTON BRINK — EDITOR

SOIL CONSERVATION

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ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

San Francisco Creek, showing bank improvement, vegetation, and regulated stream flow.

RANGE IMPROVEMENT BY WATER SPREADING

By A. T. Semple and B. W. Allred [1]

FRIJOLE and San Francisco Creeks, sister tributaries of the Purgatoire River in southeastern Colorado, the one an ugly twisting barranca, void of trees or brush along its course, its flood-season waters gnawing gullies in the naked soil; the other a pretty, meandering drainage with thickets and tree growths to its water's edge, present today convincing examples of the over-grazed watershed stream and the stream flowing through land that has known the solicitude of soil-conscious owners. Along Frijole Creek can be seen huge webs of gullies and gulches, cut by the erratic torrential rains which are common in the vicinity, until the whole drainage is in the incipient badland stage. It takes 150 acres of land on Frijole Creek to support one cow.

Over on San Francisco Creek, but a few miles away, the scene presents a picture so different as to be almost unbelievable. There the once abused and barren land has been transformed into a highly efficient farming and pasture unit. Trees grow along the streams, cattle fatten on the rich grasses, and dark green fields of alfalfa thrive on the lower better-watered lands.

The explanation lies in the story of Louis Cortese and his brother Charlie who in the year 1910 began the purchase of a ranch in the San Francisco Creek basin. Today they operate some 3,000 acres of deeded land and 320 acres of leased land. Storm waters are spread on about 2,000 acres from adjoining foothills and mountain slopes. A 30-acre field which in 1910 was principally a prairie-dog town and would not keep a saddle horse, now produces about 2 tons of alfalfa hay per acre. The whole ranch now winters 600 calves with a gain of 150 pounds per head. The only purchased feed is some 100 pounds of cottonseed cake per head.

When the Corteses acquired the land, the San Francisco Creek and its tributaries were wild, uncontrolled gullies which were eating away the heart of the ranch. The hay crop was scarcely worth the harvesting, and an 800-acre pasture which had been overgrazed for many years would not sustain five head of cattle.

Rocks Utilized

The Corteses were men of courage. They gathered up the rocks and boulders strewn over the land and built a barn 200 feet long with rock walls. They used more rocks to check the mountain floods and turn them out where the water would produce forage crops. The lesser gullies were plugged with earthen structures. Then, possessing ingenuity as well as courage,

[1] Mr. Semple is senior agronomist, Soil Conservation Service, Washington, D. C.; Mr. Allred is associate range examiner in Region 6.

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Frijole Creek, showing depth of channel and bank cutting, 3 miles from head of drainage.

the Corteses set to work to ditch the flood waters on to hay lands and broad, gently sloping tablelands where now the water is deployed out by an automatic system of spreaders.

A large part of the floodwater comes from 2 square miles of a steep mountain side which has been so grazed, by cattle only, that it has a good cover of shrubs and grass. During the last 25 years no increase in run-off intensity has been noticed. (On similar slopes outside the Cortese properties where goats have destroyed most of the vegetation, the land is slashed by deep arroyos and it takes more and more acres, each year, to keep a goat.)

Torrents Checked

From this steep slope, after a rain, the water rushes in a torrent down its rock-bottomed channel. At times, the force of flow is so great that a horse cannot cross the channel. Occasional floods move boulders as large as 4 feet in diameter. At one point across this intermittent stream, which may run three or four times during the growing season, the Corteses have built a check dam of brush and rocks. The dam is about 12 feet long and less than 5 feet high. The cost was 3 days' work for two men.

This structure lets enough water into a V-shaped diversion ditch to cover about 500 acres. The ditch is 4 feet deep and one-half mile long. Farther down the natural channel there are other similar dams. The second one consists of brush and rocks as does the first, is about 10 feet long, and diverts water for some 120 acres.

Self-Cleaning Ditches

These ranchers have found that it is particularly important, in order to keep down operating costs, that their ditches be self-cleaning. This is especially true where they run through rough brushy land where teams cannot be used. They have one $500 ditch, a mile in length, which had to be abandoned because it has too little gradient and fills with silt. Having to clean a ditch is to them like having to buy the land all over again. For their conditions, where the water carries considerable silt, they like to have a velocity that will carry the silt without inflicting further damage.

From the diversion ditches, spreader ditches made by plowing one to three furrows carry the water on to the high points of the alfalfa meadow and western wheatgrass (blue joint) pastures. Wherever the water concentrates after having covered the land, another spreader furrow picks it up and spreads it again. Generally the spreaders are 100 or more feet apart. As this process continues, the water discards more and more silt and clay, and by the time it reaches the stock ponds it is almost clear. In the Cortese ponds there has been no appreciable silting within the past 10 to 15 years. (Think what that would mean to the life of our large reservoirs!) With seven such ponds, the Corteses have never had an animal bog down.

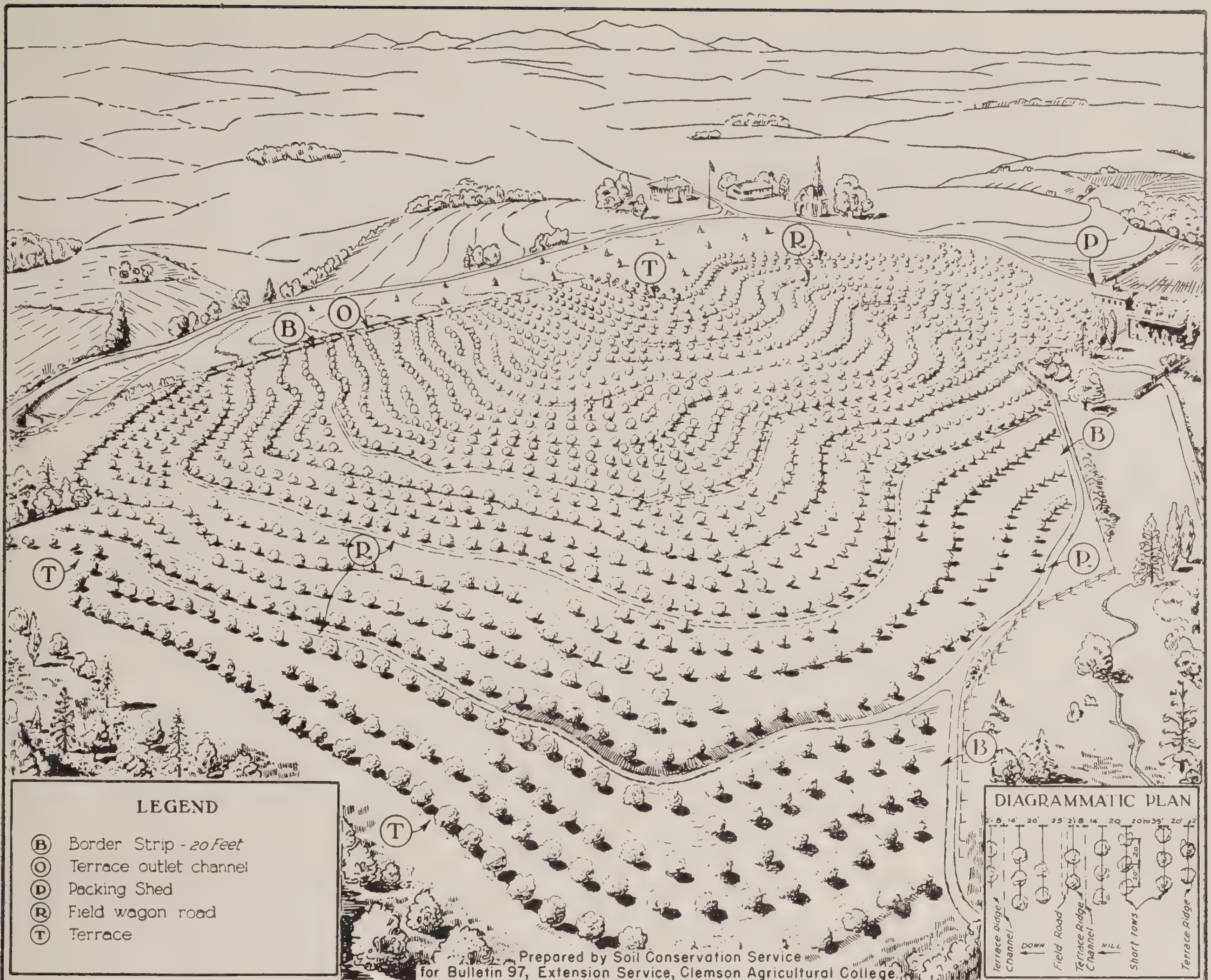
As for the spreader furrows, generally these become narrower and have slightly more gradient at the farther end.

The sediment picked up on the mountain side and deposited on the pastures is highly valued by these ranchers—this because of its fertilizing value. The initial flow after a long dry spell, being dirty and full of organic matter, is not used for stock water.

We were told by Louis Cortese that this water-spreading system causes 1 acre to produce as much as would 10 acres without it, and this checks very closely

(Continued on p. 288)

Earth check dam (shown between the two x's) in pasture gully on Cortese property, built 22 years ago. About 200 yards above it there is a similar structure which diverts water for 32 acres of meadowland. The bottom of the arroyo is nearly 15 feet below the top of this dam, which supplies water for 5 acres. It is estimated that the two dams could be built in 10 days by two men with teams and slips. The water for both comes from 100 acres of shaley soil on one side of the hill in the immediate background.



ORCHARD *Conference*

By C. L. Hamilton[1]

APPLES, pears, and peaches are produced in three-fourths of the States. The total annual production for the United States amounts to more than 150 million bushels of apples, 50 million bushels of peaches, and 20 million bushels of pears. Citrus fruits are grown in the South in the Gulf States and in the West, principally in California the total amount being over 75 million boxes. Besides this, the annual production of small fruits and nuts amounts to several million tons.

[1] In Charge, Technical Unit, Engineering Section, Soil Conservation Service, Washington, D. C.

The greater number of the orchards and vineyards from which this fruit comes are located on sloping lands where soil erosion may be a serious factor. Field observations indicate that some of the most serious erosion in the country occurs in peach orchards in the South and East and in some of the square-planted, irrigated orchards in the West. The practices of square planting and clean cultivation, without any regard for direction, degree or length of slope, have so accelerated erosion that abandonment of large acreages is often necessary. In many places there is excessive loss of topsoil, and slopes are riddled by gullies. Too often young orchards must be aban-

doned at the very stage where they should be coming into full production. Others may be carried for a longer period, but the continuous loss of topsoil and expensive fertilizer prevents profitable yields and quality.

In striking contrast, foreign orchards and vineyards are, almost without exception, not only planted on the contour where the land is sloping but in many places are provided with supporting walls and terraces to bench the hillsides and conserve rainfall, to check erosion, and to facilitate proper cultivation and fertilization.

Problem Complex

Some time ago T. B. Chambers, head of the section of engineering, concluded that erosion control in orchards, particularly with regard to the establishment of new orchards, was an important problem in many of the Service demonstration areas. Investigation revealed the fact that practically no published literature or experimental data on the control of erosion in orchards exist today. The recent bulletin, "Orchard Terracing", by the Clemson Agricultural College, Clemson, S. C., is one of the first of its kind to be published. Additional complications are added to the problem by the nature of present orchard-culture practices. Because of the extensive measures that must be used to combat insect or disease infestations, and the direct influence of changes in fertilization or cultural practices on yields and quality of fruit, orcharding is a specialized field.

The Service has a few field technicians who have had some experience and who have devoted considerable thought to the control of erosion in orchards. Also, throughout the regions there are some orchard farmers who for a number of years have been practicing one or more erosion-control methods.

To Pool Ideas

After consultation with the various regional conservators and technical sections involved, it was deemed advisable to hold an orchard conference. By this method it would be possible to pool the limited experience and ideas available and to develop recommendations for basic practices to control erosion in orchards. It was believed that such recommendations would serve as a foundation for the development of a more detailed and complete plan for application in the regions concerned. Approval was finally secured and it was decided that two orchard specialists, preferably an agronomist or horticulturist and an engineer, from each of the interested regions should attend the conference.

Conference Procedure

THE CONFERENCE was held March 15–19, with Region 1 represented by C. A. Frye and John T. Bregger; Region 2 by M. L. Nichols and Ernest Carnes; Region 3, William B. Nivison and Frank Trull; Region 5, W. D. Teare and Ben B. Sproat; Region 10, J. G. Bamesberger and Fred Herbert; and region 11, T. A. Steele, and C. C. Johnson. The Bureau of Plant Industry appointed Dr. F. P. Cullinan and Dr. J. R. Magness to act in an advisory capacity on orchard culture. This group, together with representatives from the engineering, agronomy, and erosion practice sections in Washington, was divided into three committees. One committee considered the development of erosion practices for stone fruit orchards (peaches in particular); the second committee concentrated on pome fruit orchards (apples, pears, etc.); and the third committee was assigned to irrigated orchards, its recommendations to apply especially to the Pacific Coast States.

All committees were brought together in a general meeting during the morning of each day to consider problems of general interest and for group discussions of the various committee recommendations. During the afternoons the committees usually met in individual groups for the purpose of revision or to develop further recommendations on their respective assignments.

Ideas Direct From Field

Field representatives came to the conference with prepared material and lists of the definite problems of their areas. The interchange of ideas resulted in the development of certain basic erosion practice recommendations for orchards, and when the complete report of the conference is compiled and distributed among soil conservation workers it is hoped that the information will partially supply the needs of those interested in this special phase of the work. Such recommendations as can be set forth in this article must of necessity be more or less general. They will be confined primarily to the establishment of new orchards, for it is here that it is possible to introduce the most effective erosion-control practices.

General Recommendations

AS IS CUSTOMARY in all the work of the Soil Conservation Service, the orchard-management problem for erosion control was considered as

RECOMMENDATIONS IN BRIEF

1. New orchards should be set out in areas recommended by the various State experiment stations, extension services, and good orchardists, and subsequent fertilization should be in accordance with their recommendations.

2. In general, it is hazardous to plant orchards on soils where severe erosion is already present or where there is a root penetration depth of less than 3 feet.

3. A systematic plan showing complete lay-out of orchard (tree locations, roads, turn rows, terraces, cover strips, etc.), should be prepared for new orchards before planting.

4. Orchards requiring seasonal cultivation should be limited to approximately the same slopes as are recommended for cultivated farm crops.

5. Relatively steep slopes can be used for noncultivated orchards provided it is possible to establish and permanently maintain an erosion-resistant cover.

6. Contour planting and tillage should be recommended for all orchards except possibly on some of the A slopes.

7. Both winter and summer cover crops, buffer or alternate middle strips, should be used in cultivated orchards wherever possible to maintain fertility and retard erosion.

8. Terracing is recommended if cultivation is practiced during rainy seasons or if adequate vegetative cover cannot be established and permanently maintained. The major justification for terraces in orchards with permanent cover is moisture conservation.

9. Individual terraces for each main tree row, with trees planted on the terrace ridge, seem preferable.

10. Bench terraces are recommended where necessary for steeper slopes to conserve moisture, check erosion, and facilitate orchard work.

11. Furrow-irrigated orchards should generally be laid out and cultivated according to irrigation grades required for uniform water penetration with the furrows serving the dual purpose of irrigation and erosion control.

12. Mulching is an effective erosion-control measure for orchards and its use should be given more consideration.

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a whole by all committees. The ultimate objective was to develop a plan of proper land treatment in orchard areas that would check erosion, be practical in its establishment without hindrance to the control of harmful insects or diseases, and would not materially curtail the yield and quality of the fruit or interfere unduly with necessary and desirable orchard practices and culture. In seriously eroded orchards, it may become justifiable to introduce control measures that will temporarily reduce yields or quality, but this will be done only where no other known control measure will adequately retain the soil. The retention of the topsoil and the eventually increased quantity of fruit due to an extended bearing period will more than compensate for a temporary reduction in yield.

Sites for New Plantings

New orchards should be set out only in areas recommended by the various State experiment stations and extension services as having satisfactory soil, climate, air drainage, etc. They should not be set under conditions where severe erosion is already present unless the field is first prepared by an adequate soil-building and erosion-control program. In general, it is hazardous to plant orchards on soils that have a root penetration depth of less than 3 feet. High water table, rock strata, or impervious clay subsoils usually mark the limiting depth of root penetration. This general standard of 3 feet should be increased somewhat as we go westward into the section of less rainfall, and it may be decreased slightly in the Northeast where moisture conditions are more favorable. Orchard fertilization, spraying, and general management should be in agreement with State experiment station recommendations.

Lay-Out

A detailed topographic map showing a complete and systematic plan of necessary terraces or outlets, permanent structures, roadways, or cover strips, as well as all tree locations and row arrangements, should be made for the entire orchard site. In making the plan, it is particularly important that such factors as equipment to be used in tillage, and spraying and harvesting methods be considered. Roads leading to the orchard should be sodded or otherwise protected from erosion, and definite sodded turn rows of ample width should be provided in all orchard lay-outs. Straight radial rows can be incorporated in contour-planted orchards provided there is assurance that all erosive field operations will be conducted on the contour. Straight cross rows are often desirable for the purpose of facilitating orchard work.

Stone Fruit and Other Cultivated Orchards

FOR THE DEVELOPMENT of erosion-control practices, orchards that require complete or partial cultivation can be considered in the same general category as field-row crops. In general, the same slope limitations and erosion-control practices should be applied. On A slopes the necessary tillage should be mainly across the slope, with the final cultivation always across the slope. Both winter and summer

cover crops should be used wherever possible for the maintenance of fertility, to keep up the organic content of the soil, and to prevent erosion. On slopes approaching the B classifications, contour planting and cultivation should be considered; and where the slope is definitely B or BB, contour planting should always be used. Additional recommended practices for the B and BB slopes are terraces, buffer strips, cover crops (alternate middles) and contour tillage.

Cultivation and Cover

No cultivated orchards should be planted on C slopes unless adequately protected by bench terraces. Critical slopes in fields often should be left out of orchards and planted to permanent vegetation. At the present time there seems to be insufficient evidence as to the advisability of attempting permanent sod in peach orchards. This is due to its effect on the tree yields and growth. It is generally felt, however, that clean cultivation or the neglect of covers is overdone in the majority of the regions. Permanent buffer strips have been found satisfactory in many areas. Other sections recommended cover on alternate middles, and these should be rotated annually or at regular intervals. If possible, new strips should be planted before the old strips are plowed under.

Pome Fruit and Other Noncultivated Orchards

WHERE THE ORCHARD is maintained in permanent sod it is not necessary to limit the slope of the land for orchard planting—that is, providing the farmer is willing and that it is possible to follow adequate erosion-control practices. This implies permanent maintenance of adequate cover. Alfalfa and sweetclover should be recommended as permanent cover only on soil with a high water-holding capacity, where rainfall is ample, and where the soil reaction is suitable. In order to establish an erosion-resistant cover, it is important to include some grasses with the alfalfa and sweetclover. The perennial or self-reseeding annual grasses or legumes, such as the lespedezas, should be used in other areas. Grass mixtures are usually recommended because of the denser cover and because there is less chance of seeding failure.

Production of adequate sod should be assured by the application of lime and fertilizer in accordance with good pasture practices for the respective locality. This application should be made in addition to that for the normal requirements of the trees. It should also be borne in mind that when the orchard is kept in permanent sod cover the tree will require more nitrogen than when clean tillage is practiced. When it is necessary, due to a root-bound condition, to break the sod in orchards on sloping land, this should be done in alternate middles on the contour.

Care of Permanent Sod

Mowing of the orchard is recommended especially where moisture conservation is necessary. Where weed control or moisture conservation are not controlling factors, mowing should be delayed until the grass is practically mature. Mowed material should be left where it is cut or spread under the branches of the trees for mulch. But all vegetation should be kept 2 or 3 feet from the trunks, to avoid providing a harbor for mice. A small amount of hoeing directly around the tree is particularly desirable in young orchards. The cut material should never be used for livestock feed because of the possibility of poisoning from spray residues and because of the loss of fertility to the orchard. Fire-control practices such as cultivated fire lanes on the contour or across the major slope should be maintained where there is a fire hazard.

Where permanent sod is maintained, the major justification for terraces is moisture conservation. Since some overtopping is not harmful under these conditions, level terraces are usually advisable. In certain areas where soils are very impervious the use of graded terraces may be necessary, especially where a good sod cannot be established. Better moisture distribution over the entire terrace interval may sometimes be secured by using contour furrows between terraces, but where a good sod cover is maintained it may be satisfactory to use contour furrows alone.

Irrigated Orchards

WHERE FURROW irrigation is used, orchards must be properly laid out so that correct grades for uniform rates of water percolation and minimum scouring can be secured. In furrow irrigation short rows should be used; this will cut down the head of water and secure proper distribution. The length of runs, however, is governed largely by the type of soil and other field conditions. The irrigation furrows should be constructed so that they will serve the dual purpose of irrigation and erosion control. If the overhead method of irrigation is used, provision must be made to take care of storm water by vegetative or mechanical means. In all new orchards, tree rows should be laid out so that the irrigation and tillage can be accomplished on nonerosive grades.

In established square-planted orchards on sloping lands, there is no practical method of avoiding erosion

(*Continued on p. 276*)

① *Plowing-in an annual ditch.* ② *Annual ditch constructed on 2 percent grade in cherry orchard.* ③ *California orchard terraced on contour.* ④ *Severe damage to good apricot orchard. Grass in foreground stopped the rills.* ⑤ *Plowing under natural cover on slope of about 50 percent.* ⑥ *Bench terraces in orange grove, developed through cultivation only.* ⑦ *Young orange grove on terrace.* ⑧ *Monuments to erosion's workings.* ⑨ *Young peach orchard in Michigan, under summer cover.*

(Continued from p. 274)
with furrow irrigation except by the use of adequate cover crops. An alternative by which erosion may be partially reduced is to run the irrigation furrows diagonally, at the same time securing the best possible grades. This, however, will involve a revision of the irrigation system.

Since cover crops are of primary importance in erosion control, further investigation is needed to determine suitable species for irrigated orchards under western conditions with particular emphasis on their moisture requirements. Heavy users of moisture deplete available water and may necessitate additional irrigation water. Where conditions permit, the possibility of using a suitable cover crop should be thoroughly explored before resorting to other methods.

Terracing

IF THE ORCHARD site soil is erodible, if clean cultivation is to be practiced, or if an adequate vegetative cover cannot be established or permanently maintained, it is recommended that contour planting and terracing be completed immediately prior to or subsequent to planting. It is really preferable that the terraces be constructed wherever possible before the trees are planted. Where terraces may not be provided for each tree row prior to planting, master terraces at the regular terrace interval should be constructed. This will provide protection to the intervening rows while their respective terraces are being developed by subsequent tillage operations. Bench terraces should be used on the steeper slopes where the construction and maintenance of ridge-type terraces is impractical. After the initial ridge with water channel has been constructed, the benches are usually developed by orchard-tillage operations and in connection with vegetative strips between the rows.

A terrace for each main tree row seems to be preferable, and it is felt that the trees should be planted on the terrace ridge. With this practice the size of the terraces will depend somewhat on the spacing between tree rows. When trees and terraces are established in this manner each row of trees will have more uniform soil and moisture conditions. The terrace ridge usually contains a high percentage of topsoil, and the concentration of moisture in each terrace channel immediately above the tree rows should give the most favorable growing conditions.

In terraced orchards some deviations from normal tree spacing may be advisable. When a terrace is used for each row a wider spacing between rows, with a closer spacing within the row, will reduce terracing costs per acre. It will also facilitate contour cultivation and equipment movement within the orchards, and will still provide the same number of trees per acre. The usual procedure of providing suitable terrace outlets, nonerosive grades, and ample terracing channel capacity should be followed for orchard terraces. The latter is particularly important where overtopping would be detrimental. Systematic maintenance work should also be emphasized.

Where square-planted orchards are already established, terracing becomes very difficult without seriously damaging the trees. In the majority of old orchards, terrace construction is usually impractical. If topographical conditions permit, regular terraces should be constructed only in old orchards where the benefit by increased life and moisture conservation will overbalance the loss (normally anticipated) by the removal of trees. Some growers estimate that terrace construction is practical when not more than 8 percent of the trees have to be removed. Usually standard spacing and channel capacity should be provided for terraces in old orchards.

Mulching

THE APPLICATION of mulch as an erosion-control measure in orchards and vineyards should receive much more attention. This is especially true under conditions where a permanent sod or semi-permanent cover crop is difficult to maintain, and where available moisture is limited. Mulch in orchards effects much the same kind of erosion control as leafmold and litter in the forest. An advantage of mulching over cover cropping is that the mulch will conserve moisture for the trees instead of taking it from them. With a proper depth of mulch, weeds are eliminated and, as the straw or other mulching material rots, organic matter is added to the soil.

The use of mulching materials for the purpose of erosion control will depend upon their availability or cost and their adaptation to the particular orchard crop being grown. On certain areas it may be good practice to set aside a definite portion of a farm for the sole purpose of producing mulch for the orchard areas. Insect or disease control may be a factor to be considered as well as fire hazard. The former may be partially offset by not placing mulch directly against trees, and the latter can be overcome to a large extent by applying only around trees or in alternate strips or rows. When applied in strips, however, mulch should be laid as nearly as possible on the contour.

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On Opposite Sides of An Old Soil Fence

By Helen M. Strong [1]

North slope of Palouse hill showing old pioneer soil fence to the left of the modern wire fence. Grazing has been unregulated on the left-hand, bare field, but a thick stand of bunchgrass has returned on the right-hand field since grazing was regulated in cooperation with the Soil Conservation Service. Six miles southwest of Pomeroy, Garfield County, Wash.

ON THE slope of a hillside in Garfield County, Wash., there is a long ridge of soil extending from the valley flat straight up to the top of the hill. This is one of the soil fences thrown up by early pioneers to mark the boundaries of their lands. Most of these soil ridges have been plowed over until they are obliterated, but this one remains, fortunately, as a record of those times when soil instead of wood was used in the Palouse hills for fencing. Today, alongside it, appears the modern post and wire fence.

When this soil fence first was heaped up, the hillside was covered with a dense, soft stand of bunchgrass. As time passed, however, constant, heavy grazing kept the grass eaten down close to the roots, leaving the range with only a weedy growth. Apparently the bunchgrass was all destroyed. Today the fields on the left of the sod fence are denuded of vegetation, while in sharp contrast those on the right are covered with a thick stand of bunchgrass. No seed was planted, but roots and seeds dormant in the soil were given an opportunity to grow. The contrasting fields, marked by the old soil fence, illustrate definitely what can be done to reclaim denuded slopes in the area.

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The picture was taken on October 30, 1936. For the preceding 18 months, grazing on the right side of the fence had been regulated in cooperation with the Soil Conservation Service, while on the other side every spear of grass continued to be foraged. On the one field soon there will be neither soil nor forage, the land a liability to the owner; while from the other there will a be steady and increasing animal income from a stable feed supply.

There is no doubt that the condition presented on the bunchgrass side of the fence represents the natural condition on these ranges. The miles and miles of nearly bare hillsides, today criss-crossed with cattle trails, do not in any degree represent the scene as it lay before the eyes of the first travelers through this area. As for the bunchgrass, it is now found only on an occasional rocky spot which is inaccessible to cattle.

Contrast in Vegetative Cover

A little more than 20 years ago there were some fine stands of bunchgrass on the Colville Indian Reservation in Washington. Indian grazing in those areas had not been severe, so that the grass remained

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A luxuriant stand of native grass on Henry's Fork, Sweetwater County, Wyo. This view, taken by the Hayden expedition in 1870, provides a convincing contrast to the present-day denuded condition.

A stand of bunchgrass on the Okanogan Plateau, Colville Indian Reservation, 1912. This represented essentially a virgin condition, since it had been utilized only for scattered Indian grazing. The grass reached almost to the horses' knees. The taller vegetation may be needlegrass. Photograph by J. T. Pardee, U. S. Geological Survey.

almost in its virgin state, while outside the reservations it already had been grazed down to the roots. In fact, so heavy and rich was the grass when Pardee went through it in 1912 that the horses of his pack train, hungry after the thin forage outside the reservation, continually stopped to eat and had to be urged along. The same thick stand was found at that time also on the Okanogan Plateau and in the Columbia Valley, where it grew to the horses' knees.

The Hayden surveying expedition of 1870 found this same rich stand of grass in Utah and Wyoming, a vivid contrast to present conditions in areas where

A fertile grassland valley on Henry's Fork, near its junction with the Green River, Daggett County, Utah, 1870. Note the high stand of native vegetation, principally western wheatgrass, and the smooth, uncultivated valley floor. Today, the cover is missing and the valley floor is serrated with deep gullies.

weeds, annual grasses, and other growths of less forage value have replaced it in some places, and sagebrush, the secondary member of the original sagebrush association has become the dominant plant in others.

Grasses Destroyed—Gullies

In those early days the bottom lands and slopes not only were covered with a thick stand of grass, but they were smooth and unscarred by deep gullies. Grass cover was sufficient to hold the soil, even under the impact of heavy downpours on the slopes. This same grass controlled flow of water so that floods did not cut gullies into slopes, over roads and fields, and into the lower level areas. Then, the Palouse Hills around Pullman and Moscow did not show gullying nor had the best of their topsoil been washed or blown off. Now, removal of the climax vegetation that through long periods had established itself has started an entirely new erosion cycle. If allowed to continue it will wear down these hills, lower the water table, and finally, after ages, another climax vegetation may develop; but neither the present generation nor their children and children's children will be concerned with this. The immediate heritage will be bare soil, rough land, and a mere subsistence or starvation condition unless the balance soon is restored in some measure.

To Restore Natural Conditions

Restoration of this balance is the aim of the Soil Conservation Service, whose work now is to stop the vicious cycle induced when the soil lost its protective cover. An opportunity is being given for natural forces to reassert themselves in reestablishing vegetation, to hold and stabilize the soil by protecting it against unnecessary losses. In this settled land present day farm conditions must be met, so that the land will support its population in the present or a higher standard of living. This means crop agriculture, not grazing alone, and the Soil Conservation Service is solving the problem of a crop and animal agriculture which will use the soil and at the same time save it for future generations.

Climatic Studies Needed

Although changes have occurred in vegetative cover, lay of the ground, and soil, it is important to remember that today we are working under the same climatic conditions as existed in the early days of exploration and settlement. Climate is characterized by the same diversity of wet and dry years, sudden torrential downpour, and long dry periods, heat of summer and cool or cold of winter, and strong winds, as have prevailed throughout historic time. To be sure, more information is needed regarding the climate of different parts of the area. Such records as exist indicate that climate varies greatly from place to place, even within short distances. A sound soil-conservation program must be based upon the climatic conditions existing on the spot, not as they are a few miles away where records may have been kept.

Farmer Cooperation

Land owners in the Pullman-Moscow area have united with the Service to develop a sound long-time agricultural program. Here for years hills had been cultivated from base to summit. The heavy plows, drills, and combines were pulled straight up and down these hills, first by teams of many horses, then by powerful tractors taking a heavy toll of fuel on the long grades and thus eating into farm profits. Even when seed had been sown it might be washed or blown out and the work go for naught.

Now, under the program, fields are protected by incorporating the wheat stubble instead of burning it. This holds the soil down through the period of fallow, breaks up the flow of water over the fields, retaining it in small hollows so that it soaks into the ground instead of running off. Rough land at the base of the

hills is sown to grass and kept for pasture. That on the summits where soil may be thin or where snow banks form each winter also is kept in pasture, leaving the smoothest and best part of the hillslope for crops. On the top of some of the Palouse hills they are planting windbreaks, using such trees as caragana, black locust, and Russian olive, which are adapted to the conditions of rainfall and temperature existing in the area. These will help to hold the snow, preventing the melted snow water from rushing down over the crop land and carrying away the soil.

Better Income From Smaller Crop Area

It is interesting to note that this smaller crop area around the hillside affords as good an income as that derived from cultivating all over the hills. Yields on the rough land at the foot of the hills and on the poorer soil of the summits were not so large as on the better soil of the midslopes. Furthermore, it costs more in tractor fuel and in labor and time for planting, cultivating, and harvesting the summits than the areas lower down. Another change in tilling the slopes, namely contour cultivation, permits machinery always to move on the level, with less expenditure of fuel and labor.

Around the foothills of the Blue Mountains an original fertile soil combined with climatic conditions has invited agriculture—first grazing, then grazing and wheat, then wheat, then the raising of peas for canneries located in such places as Dayton and Athena in the valleys. This general area has an elevation of 2,000 to 2,500 feet above that of Pullman, and consequently has a higher precipitation and humidity and a shorter growing season. For example, on the lowlands at Dayton the Pullman conditions of climate exist, precipitation progressively increases as the mountains are ascended above the town to timber line, and frosts are later in spring and earlier in the fall. This has been an advantage, for a farmer can prepare his land in the valley, seed it, then go on up to his higher acres, prepare and seed that. Harvests likewise come in similar succession, from valley bottom to timber line.

Intensive Land Use

In short, conditions that might be found in locations separated as to latitude are found compressed into a small compass around these Blue Mountain foothills. Labor and machinery on the land and in the pea canneries can be kept busy during a longer growing season than where the land is level, and market demands met for a longer period of time. All these elements have contributed to somewhat intensive use of the land, leading to severe soil use with absence of protective cover against wind and water; to loss of soil through sheet wash, gullying, and wind erosion; and in many places to cutting up of the smooth land surfaces by gullies. On more than one hill slope, soil has washed off down to the rock, or yellow clay spots of subsoil are appearing.

Here around the Blue Mountains is an area of farm lands and prosperous towns dependent upon maintaining the standard of soil fertility and an unscarred land surface. The problem was not one that could be solved on a single farm, for the interests of each farmer were linked with those of his neighbor, and those of the entire community intertwined.

The Service has mapped and studied the needs of the land and of the farm communities as to land use. Where the soil is badly washed or eroded it is being put into permanent pasture. Pulverizing the soil and keeping it bare during fallow is becoming an obsolete practice. The farmer has discovered also that by incorporating stubble and practicing a system of rough tillage he attains larger crops. He now plants with a disk drill, instead of a hoe drill which would drag up the stubble. Until recently, disk drills were not found in the stock of merchants handling agricultural supplies. Now every dealer is featuring them, because they are in demand under the improved farm practices.

On slopes which are so steep that erosion would result from continuous wheat or pea cropping, buffer contour strips of grass have been established to decrease run-off. On higher elevations approaching the Blue Mountains, where soils are heavier and rainfall higher, peas replace summer-fallow in the rotation; but farther away from the mountains at lower elevations where it is too dry for peas, summer-fallow is the rule between crops of wheat.

When the first settlers came into this country, they found grass-covered or forested slopes without gullying, and smooth valley bottoms. Streams were fringed with cottonwood and willow. There was a natural balance between erosion, vegetation, and rainfall. Wild Horse Creek, flowing through Athena, was at that time a clear stream, across which anyone could step. It flowed through willows and grassy meadows. Water seeped into it from underground drainage, coming in slowly from grass- and forest-covered soil. Although heavy rain has always fallen upon this land, the mat of vegetation took care of it and kept the streams clear and even in flow.

After the fields were cultivated, when heavy storms brought sudden high floods into Wild Horse Creek its channel was cut down until the stream flowed in a straight-walled dirt arroyo 20 to 25 feet deep across a fertile cultivated and grazed field. Cattle no longer could reach the stream for water, nor could it be crossed except where bridged. It continually was deepening and widening, threatening the entire field. About a year ago the Soil Conservation Service installed wire and rock dams a mile apart on this stream and since then the channel has filled in 6 or 8 feet. Now earth slumps remain where they fall from the sides, vegetation is taking root on them, and the entire channel is becoming stabilized. Eventually it will be a shallow grassy depression through the field.

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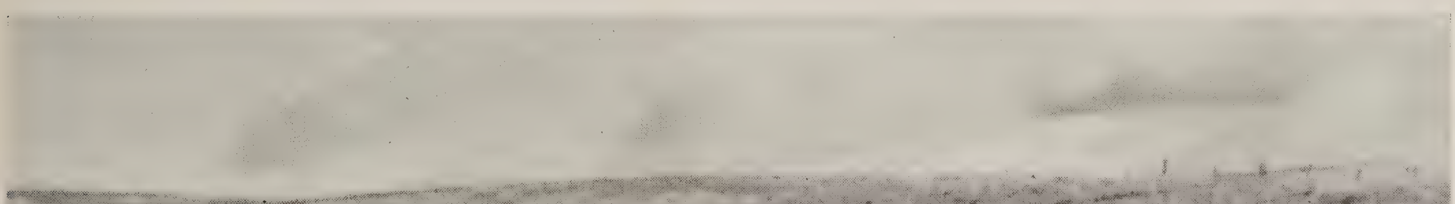
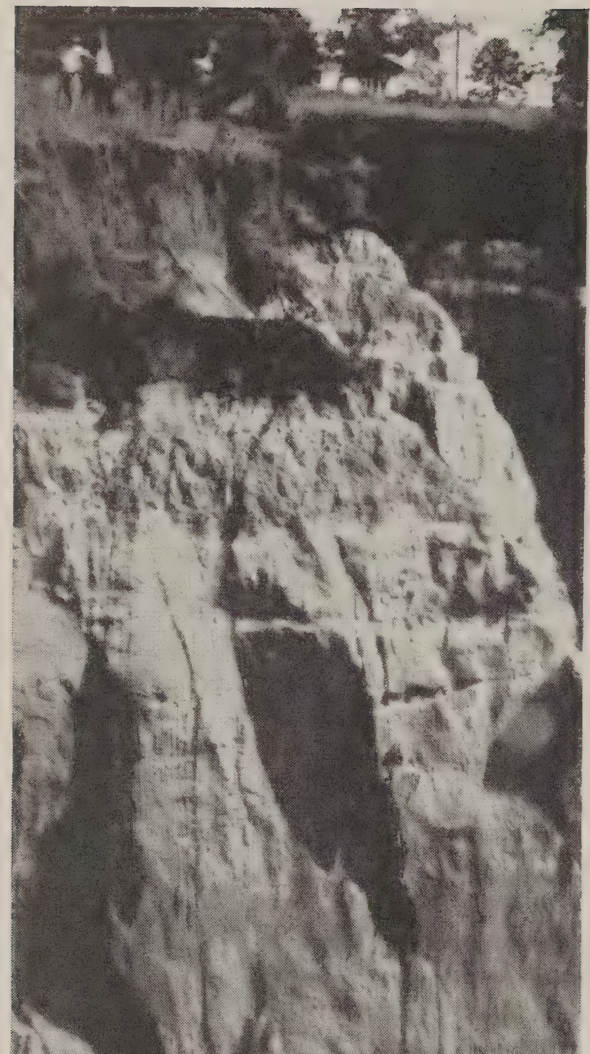
Luxuriant stand of bunch grass in 1912 on Okanogan Plateau west of Omaha Lake in Colville Indian Reservation, where up to this time there had been only scattered Indian grazing. Photograph by J. T. Pardee, U. S. Geological Survey.

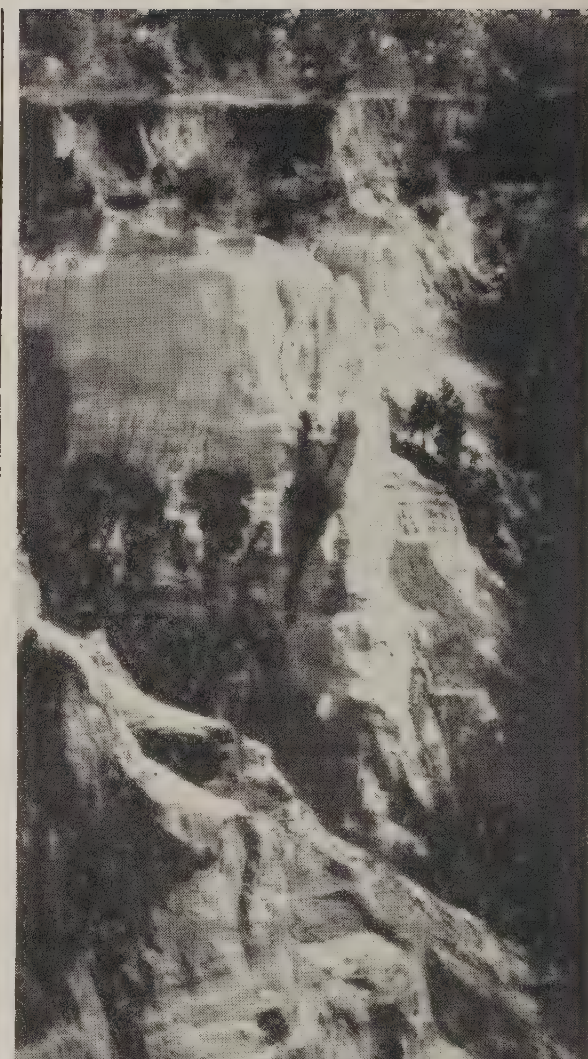
A silt flow 2 feet deep inundating a rock road. The silt is from a finely tilled summer-fallow field where the stubble was burned several years in succession. Severe sheet washing occurred over the entire slope, and gullies are starting in almost every depression. Whitman County, Wash.



The wheat stubble on this field has been chiseled and incorporated, a rough tillage method which controls run-off. A 3-inch rain did no damage.

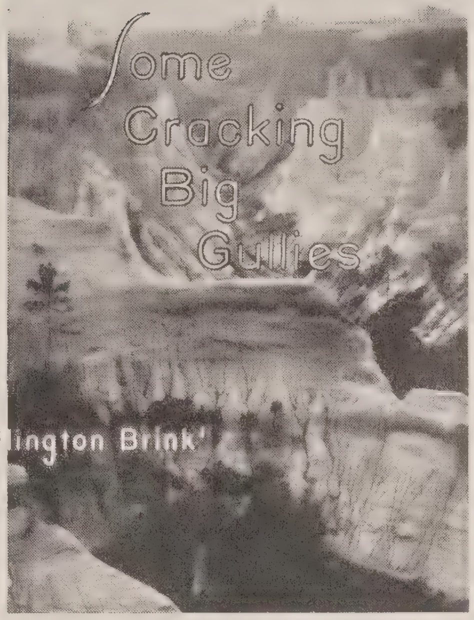


SOME CRACKING BIG GULLIES



Some Cracking Big Gullies

By Wellington Brink[1]



THE gullies of Stewart County, Ga., like the dust-storms of the West and the floods of the East, give fame and focus to the fact of soil erosion.

Stand at the end of a bean row, with Doomsday at the tip of your toes, if you would be convinced. When the earth is crumbling all around, there can be no gainsaying that an agricultural judgment day is close at hand.

It is good earth—bale-to-the-acre land, much of it—that is hurtling into the Stewart County pits. Good earth, in chunks weighing 1 ton, 2 tons, 5 tons. Not soil easily spared, as sometimes intimated; not a recumbent desolation surrendering to a wide-mouthed chaos. I don't think I ever saw lustier collards, cabbage, peas, onions or potatoes than on the farm of W. T. Halliday. Yet, week by week, month by rows are shortening, the vegetable patch is getting smaller, the farm is dropping away forever and for aye. There's a peach tree at a crazy angle, given brief reprieve on a ledge a few yards down, bursting bravely into bloom. There's a wire-and-picket fence tenaciously thrusting 6 feet beyond the edge of an abyss; no going around or climbing over today, mister. There's a persistent potato plant growing down yonder where no garden fork will ever reach it.

THE earth trembles and the thunder rolls, in glowering paradox to blue skies and sunshine. That's the artillery of soil erosion, with the customary mufflers off.

How deep is this gully? How deep is Providence Cave? How deep is Halladay? How deep is Rutledge? I toss out horizontally one pebble, then another and another. It is, roughly, 3½ to 4 seconds from the beginning of the fall to the kicking up of dust down below. The pebble drops at 32.16 feet per second. My mathematical friend calculates the depth at from 197 to 257 feet. He uses a simple method, with the factor of friction ignored—but it's close enough. And not even a Euclid can accurately estimate the cubic yards that have been swallowed by one of these gullies, for the dimensions increase and the totals leap even as the pencil moves.

IF the pebble were animate and the seconds were hours, I wonder what it would think as it makes the descent? It's a pretty swift tumble at best, in view of the geologic ages which went into the creation of the structure that has been so completely devastated within the past 60 to 80 years. There, in bold cross section, is the so-called "A" horizon—the productive surface layer; the underlying "B" horizon—likewise, aeons in the making. That which delights the eye of the artist as he stands in the presence of the Grand Canyon is also here, a little less lavishly—the craggy grandeur, the cathedral architecture, the complete spectrum. Colors fluctuate from reddish bay to dappled gray, from chaste white to royal purple, from lemon chrome to variscite green.

IT'S a spectacular scenery. Sightseers come hundreds of miles to look at it. But it's a scenery that Stewart County could do better without. To make the scenery, considerable property has been engulfed. In the last 2 years many writers have marveled at the immensity and rapidity of the damage that has ensued since the coming of the ax and the plow. They seem pretty well agreed that it was simply the pine-tree pins and the grass damask that held the land in place.

I COMMENT on a slender minaret with one doughty tree like a flagmast at its tip. "There were four trees last year", says Dasher, project manager. "Another 3 months, and there will be none."

The big gullies involve some 70,000 acres. And the giants grow fast and faster, as if stimulated by an overactive geologic gland. The lengthening process continues until the top of a ridge is reached. Highways are moved over and over again, and still they cannot get far enough out of the way. You can see the old roads of last year and the year before, where they run to meet a gully, pause for a jump of 15 or 20 yards, resume on the far side.

[1] Editor, Soil Conservation.

Go down one road far enough, and you come to a veritable delta—great beds of silt, once productive soils, now a problem in themselves. You see a 20-acre lake on your left, a 40-acre lake on your right, backed up by natural dams. "I caught a 9-pound bass there last year", says someone, with a nod of his head.

CAN'T something be done to check the process, to stabilize these gullies?

Well, you can't slope their banks with a bulldozer, plant their sides to Bermuda grass and black locusts. That sometimes serves admirably in South Carolina or Tennessee. But to do that here would be like handing the job to a child with a sand shovel—and you'd lose your bulldozer in the bargain.

How about it, Dasher? How about it Storey? How about it Chapman? How about it Bailey? Is there nothing you agronomists and engineers can offer as a possible solution?

Well, there is plenty that can be tried, and it's the kind of a challenge that commands serious effort.

HERE is one road in proximity to a gully head that looks as if it might not have to be shifted any more. That's because the Soil Conservation Service tried the expedient of a diversion ditch. The water from the slope above is carried along 700 feet or so to a point where it can be emptied into dense woods which spread it and slow it and nullify its abrasive powers. The ditch is 18 inches deep, 4 feet wide, inexpensive to construct. And I am told that it, and a number of other similar structures, are proving of some value.

Kudzu is another recourse. It has been tested on a small scale, and a more extensive use is in prospect. In view of the limited sources of seed, R. Y. Bailey, regional agronomist, is suggesting the use of two-node cuttings and of coils of vines, where supplies are available. He wants to see kudzu well established around the rims of some of these gullies to a width of 50 feet or so. He thinks there may be a chance that a thick matting of the vines will give the banks a tendency to crumble slopingly instead of vertically, and that the perennial once established will continue to grow and bind after further cave-ins. He has in mind the stabilizing effect of kudzu on smaller gullies, notably the one near Buena Vista, Ga.

COMPREHENSIVE soil-conservation measures on watershed farms are not being overlooked. If run-off can be allayed by better land use, there is a chance that the situation will be improved. I have before me the cropping plan of a 473-acre farm that drains into one of the angriest of the big gullies. It carries the specifications for 1937, 1938, 1939, 1940, and 1941. It shows 26 acres retired from pasture to kudzu within the 5 years; 4.5 acres retired from cultivation to kudzu; 15 idle acres planted to kudzu; 9 idle acres put in forest. In place of 8 acres in small grain in 1936, there will be 53.55 acres so planted. The acreage in hay will be materially increased. Rotation by strips on the contour, will be in vogue henceforth. Terraces and terrace outlets will be properly constructed on slopes requiring such protection. (It is interesting to note that 10 million kudzu plants are being planted in the region—Ga., Ala., N. C., S. C., Va., Miss., Fla.—at this time.) This is the sort of intelligence in land use which, multiplied throughout the watershed, undoubtedly will help to save soil, water, and gully thievery. Whether or not the cracking can be stopped, remains to be found out.

An Old Soil Fence

(*Continued from p. 280*)

Farther up on Spring Creek, a tributary of Wild Horse Creek, may be seen today an excellent example of stream-flow control by means of the small pole dam. This creek, formerly clear and constant in its flow has in the past few years regularly became dry. The pole dam built by the Service holds the water back and prevents floods below. Even during the past dry summer which was equally as dry as those of preceding years, this stream has flowed continuously. A fence formerly close to the stream has been set back about 20 or 30 feet, affording an enclosure where cattle cannot graze. Within these 12 months, although no seed has been sown, bunchgrass has come back into this small enclosure and has spread up from the stream 10 or 15 feet—evidence of the raised water table.

A short distance below this point a large gully had worked it way back from the stream into the bluff. It was fed by run-off from a plowed field, and was cutting into a plowed wheat field, the run-off from which continually enlarged, widened, and deepened the gully. This wheat field was one upon which the farmer depended for a good crop, but the gully and the loss of topsoil through the gully was fast destroying the field. In order to protect his field, the farmer urged that wire check dams be placed across gullies. This was done and at the same time the farmer abandoned his practice of plowing furrows straight up and down the hill and substituted contour plowing. In addition, after his wheat was harvested, he incorporated the stubble. A number of heavy rains have occurred; yet under present conditions no water has run off the field to back up behind the wire dams in the gully, although it was the rainfall from this very field which created the gully. No more vivid illustration can be found of the effectiveness of gully-control work.

Constructive farm practice now is no longer confined to the areas of soil-conservation projects. Passing along the road through farms adjacent to the project, one is impressed with the way in

(*Continued on p. 286*)

SOIL CONSERVATION AND THE C. C. C.[1]

By J. G. Lindley[2]

THE Civilian Conservation Corps is an organization carrying forward a broad national program of conservation—conservation of natural resources and of human resources. Its administration is under Robert Fechner, Director of the Emergency Conservation Work; and the operation of the camps is the joint responsibility of the War Department and a Federal using service. The using service may be any one of a number of bureaus or services under one of the Federal departments of the United States Government.

The Soil Conservation Service in the Department of Agriculture is one of these cooperating agencies. Camp educational advisers have been furnished copies of an outline of instruction in erosion control. Many camps are already carrying on courses in soil conservation, and others plan to do so in the future. For that reason, it might be well to explain something of the background of the Soil Conservation Service, its objectives, and its work program.

PERHAPS the most important reason for carrying his message on to the enrollees is that a large number of them are from farm homes. They will go back to their farms. If we, through work in the fields, and through the educational program in the camps, can give them a clear idea of the need for soil and moisture conservation, and tell them how they may adapt this work to their own individual farms, our program of conservation will be advanced very materially.

Last summer duststorms choked the western plains. Any of you who has ever been in one of these duststorms will know the horror and despair that they may cause. At the same time that the Great Plains Region was crying for moisture, floods were surging throughout the East. Also at the same time, thousands of once productive acres in the South lay completely abandoned, worn out by erosion. Duststorms in the West, floods in the East, abandoned farms in the South—all these are due to a single cause—the failure of man to take steps to retain moisture where it falls, or in the case of excessive rainfall, to conduct the surplus water safely from the fields. As early as 1873, over 60 years ago, Elisee Reclus, the famous French geographer said: "Among the causes which, in the history of mankind, have effected the extinction of so many forms of civilization we must place in the first order the reckless violence with which most nations have treated the soil which nourished them."

There is, then, a definite need for erosion control, whether it be by the Soil Conservation Service, Forest Service, T. V. A., or some other Federal or State organization. The main thing is to make the public aware of the necessity for soil conservation, and to get the job of demonstrating erosion-control measures done and done properly.

THE using services have no authority in the educational program—no official responsibility; but we do have an ethical responsibility, and if we fail to do all we can to make the enrollee a better man and a better citizen, we shall not have completed our task, even though every gully in the United States is plugged.

The Soil Conservation Service is a new organization. It is even younger than the C. C. C. It was not until April 1934, a year after the C. C. C. first started, that we received our first camps. Twenty-two camps were allocated to what was then the Soil Erosion Service. Public reaction to the work of the camps warranted their continuance and their increase in number. Today, the Soil Conservation Service is operating 156 watershed demonstration areas and 450 C. C. C. camps.

I might point out here that the Soil Conservation Service is not a relief organization. Its work is forwarded on a cooperative basis with the farmer. In each area, a comprehensive demonstration is made of practical methods of erosion control suitable to that particular area—work that the farmer himself can carry on after the camps have completed their demonstration and moved to other areas where their work is needed. Neither is the service a reclamation organization. No efforts are being wasted in trying to reclaim land where the soil is irrevocably lost. We are trying to save the good land that still remains.

ACCOMPLISHMENTS of the Service must be measured largely in terms of influence upon agricultural thought and action, inasmuch as the program thus far has been based primarily on the principle of demonstration. Indicative of this influence are the results of a recent survey showing that 35,500 indi-

[1] Excerpts from a paper presented at Fourth Corps Area C. C. C. Conservation and Education Congress, New Orleans, La., Feb. 26–27, 1937.
[2] Head, E. C. W. operations, Soil Conservation Service, Washington, D. C.

vidual farmers within the demonstration areas are cooperating voluntarily in applying a complete soil conservation program to their land. Of far greater importance is the fact determined in the same survey that conservation farming practices employed within demonstration areas of the Service already have spread to nearly 55,000 individual farms outside of Service work areas. Such spontaneous acceptance of these practices indicates a widespread and rapidly growing consciousness of the need for land preservation, and constitutes a criterion of the extent to which farmers of the country are translating this consciousness into action.

Let me again state that we hope to assist, not only the farmers, but also the 70,000 boys who are enrolled in S. C. S. camps. We are very anxious to make the soil-conservation courses in the camps interesting and effective. As we are a new organization, I am sure that in the past our men have been somewhat reticent about cooperating in the program, possibly feeling that they might step in where they were not wanted. I am equally sure that the feeling must be and is being dispelled, and I wish to assure you of our desire to cooperate in this all-important work. In Soil Conservation Service camps technical men will be available to aid in instruction if the advisers so desire. Outlines of unit courses to continue the present lessons in soil conservation, soil, agronomy, engineering, and woodland management into the more advanced stages are in preparation.

Orchard Conference

(*Continued from p. 276*)

Rates of mulching will depend upon several factors, such as the kind and cheapness of material used, slope, type of application, etc. Where mulching of "bald spots" is practiced, at least 2 to 3 tons per acre will ordinarily be required to control erosion. This practice is gaining favor in many areas. For some areas contour furrows combined with mulching may be advisable to provide the necessary moisture conservation.

Conclusions

FORMULATION and application of erosion-control practices for orchard lands present new problems, the details of which differ from those encountered in areas devoted to annual field crops. Due to the large acreage and wide distribution of orchards the problem is serious for the nation as a whole. Some orchard soils are being eroded so rapidly that the growers are becoming alarmed and are willing to comply with any reasonable recommended practices which will save the soil and thus, the trees, Many of these growers realize that if their orchards are to continue to be productive they may have to sacrifice temporarily some production and income.

Various erosion-control methods are being practiced by progressive orchardists; in fact, the program which the Soil Conservation Service hopes eventually to inaugurate will not be entirely original. Several methods of soil conservation have been tried by one orchardist or another. Few of them, however, have included all of the soil-conservation principles on individual orchards. It is believed that the greatest accomplishment will be achieved by developing a more complete erosion program for orchards and by helping each orchardist to become familiar with all applicable measures, their application and proper timing of operations. Whether it be sowing or turning under of cover crops, the construction of terraces or annual furrows, subsoiling or cultivation, or the application of fertilizer, the time it is done and the local details involved will be important factors in obtaining favorable results.

An Old Soil Fence

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which farmers have adopted practices which they have seen carried out within the project areas. However, there is need for a much wider spread of constructive land use. In passing through such areas as the Umatilla, Snake, and Yakima Valleys, with their fertile areas, green even in late October under the mild lowland climate of the "Banana Belt", one cannot but feel the necessity for changing farm practices, and the significant interrelationship of hillside watershed and irrigated valley land interests. Here luxuriant crops of vegetables, apples, pears, and peaches can be grown only because of the fertile soil, the warm climate with its long growing season, and the supply of water. Eliminate any one of these three factors and the entire agriculture of the valley with its accompanying town life and market distribution probably ramifying to the Atlantic and the Pacific would disappear. The climate cannot be changed, the soil can be kept only if the land is properly managed; it is the water over which man has the most control.

Irrigation Problems

The irrigation water comes into these valleys from streams whose flow is made steady by forest and grass cover on the watersheds. Should the water flowing through the irrigation ditches become laden with silt, it would tend to clog the pore spaces in the soil, and finally prevent percolation of water down below the surface to the roots of orchard and farm crops. Furthermore, the irrigation ditches and reservoirs would become clogged and their capacity diminished, thus cutting down the acreage which can be cultivated.

Thus it is that even in the area of eastern Washington and northeastern Oregon, the Soil Conservation Service is facing a complex of interrelated agricultural and physical conditions, presenting problems the solution of which lies in their coordination toward maintenance of the soil itself and its fertility as the end in view. This must be done in order that the people of the region may keep for themselves and their children the standard of living won so courageously by those who settled the area.

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

THE FUTURE OF THE GREAT PLAINS.

Great Plains Committee. Washington, D. C. 1937.

No one knows why it is that it takes a catastrophe to awaken the human creature to a knowledege of his own shortcomings. Yet such is the case, as evidenced by drought conditions in the Great Plains areas during the years of 1934 and 1936. For a good many years cultivation methods as practiced in the region had been injuring the land to such an extent that large areas were becoming increasingly unproductive even in good years; yet nothing was done in the way of a definitely constructive program for Great Plains agriculture until drought and unprecedented dust storms swept the land, leaving in their wake ruined crops and homes and conditions so deplorable as to necessitate immediate emergency relief on the part of the Federal Government. Results of studies made under the emergency program point to urgent need for coordinated drought-control measures over a long period of time to save the soil and water of the region and for the readjustment of its agricultural life. A realization of the true conditions led to the appointment by the President of the Great Plains Committee whose studies are summarized and recommendations submitted in The Future of the Great Plains.

Judging from the report of the committee it is apparent that at present the legal aspect of the problem is particularly urgent. With thousands of farms, covering millions of acres, in such a state that they should no longer be plowed, with tenancy on the decided increase, and tax delinquencies rapidly bringing about a vicious circle of higher tax rates on a diminishing tax base; with the persistent use of high cost water for cash-crop production on lands of low productivity; with dependency on the increase and inadequate and excessively variable incomes all over the region—all these factors, coupled with a noticeable impairment of individual and community stability, emphasize the importance of coordinated Federal, State, and local legislation for future land and water utilization throughout the 10 States comprising the Great Plains.

With proper legislation for the future stability of the Great Plains in view, the need for facts as based on careful investigations and surveys is urgent and immediate: Facts concerning the past and present uses of land and water; land ownership and land tenure and cultural practices on the many and various types of land within the region; the facts about climatic risks as relating to settlement and agriculture, topography and soils; soil erosion conditions throughout the whole region and soil capacity with regard to plowing and cropping, grazing of grass lands, lands which should be left in natural cover; water supplies, both surface and underground, with irrigation possibilities as related to the needs of all small and large farms; the economic capabilities of all people not enjoying a decent standard of living.

Some of these studies are already well established under guidance of various agencies and departments of the State and Federal Governments. But, as set forth by the committee, it cannot be expected that they will achieve permanent success without uniform and adequate legislation involving local and State bodies to provide for a workable conservation program in the region. At the time the report was filed "adequate State legislation for a State-wide program of erosion control on private lands is lacking in each of the 10 States."

Only three of the Plains States—Texas, Kansas, and Oklahoma—have passed laws providing directly for erosion-control operations. The Kansas law has been declared unconstitutional by the State supreme court. The two Texas laws represent the greatest State achievement to date in legislation for soil-erosion control. As no provision is given, however, in either law, for essential changes in land use or complete methods of voluntary cooperation of the farmers, these laws fall short of requirements under the Federal policy for land readjustments and conservation of the soil and water of the Great Plains.

It becomes apparent, therefore, that in order to command substantial cooperation from landowners and farmers in the Great Plains, we must turn to State legislation to supplement the Federal programs. With this important objective in view, the President has recommended to the State legislatures the adoption of a Standard State Soil Conservation Districts Law. "In essence this law provides a procedure by which soil conservation districts may be organized. They are to be governmental subdivisions of the State. In the main they are to exercise two types of power: (1) To establish and administer erosion-control projects and preventive measures; and (2) to prescribe land-use regulations designed to prevent and control erosion. Such regulations are to have the force of law within the district."

The proposed State law, which is based on recommendations of the Land Policy Committee, the Soil Conservation Service, representatives of a number of States, and the Office of the Solicitor, is believed adequate to meet the constitutional and legal requirements of the program. Under the law local agencies for erosion control could be established, and within their respective areas they could perform intensive control operations. The lands of those who did not cooperate voluntarily in control programs could be brought within the influence of the operations, thus preventing the washing and blowing of soil from such lands onto adjacent areas engaged in erosion-control operations.

By the first of April legislation closely paralleling the Standard State Soil Conservation Districts Law had been enacted in several States in the Great Plains area.

Another legislative problem that must be solved is that providing for a sound conservation program for the retirement, proper administration, and more appropriate use of submarginal lands. According to the recommendations of the committee this legislation should include statements as to the purpose of the land acquisition, and legal methods for acquiring the land through purchase, condemnation, gift, and exchange. It should include also authorization to acquire the property and for the purchase of title. It is suggested that such legislation might well be based upon the land-acquisition programs of the States of New York and Wisconsin.

A serious problem is presented by the jumble of tax statutes now existing in the Great Plains States. In many areas tax-delinquent lands lie neglected or abandoned to misuse and erosion because of notable defects in present procedures both for acquisition by public agencies, and for their administration by such agencies after acquisition. While such a situation exists little can be done throughout the region in the way of land readjustments for control of wind erosion. Legislation for the correction of the conditions "* * * should authorize the acquiring agency to improve and manage the lands, to lease them, and to exchange them for others. Finally, provision should be made to transfer such lands from subdivisions of the State to the State, or vice versa, in order that the most appropriate agency may administer the lands for the new land uses."

It is proposed by the committee that in order to restore the range, control erosion, and stabilize the livestock industry, grazing be

regulated by law. Since much of the soil erosion in the Plains region is directly caused by overgrazing, it is thought that grazing regulation can be made effective in any State adopting the Standard State Soil Conservation Districts Law.

For a readjustment of water utilization to land use the committee recommends immediate investigation and analysis of all forms of water districts and powers now existent in the Great Plains States. This would enable the formulation of a definite plan of legislation for uniform water control and preservation in this region where water is often scarce and every drop of it precious.

Appendices included in the report are as follows: The President's Letter of Instructions; Acknowledgments; Soil and Water Conservation in the Great Plains Typical Results of Operations Program; Benefits Derived by Areas Surrounding Irrigation Projects; The Montana Land-Use Study; A Montana Cooperative Grazing Association; A Standard State Soil Conservation Districts Law; Summary of Texas Legislation on Soil Erosion Control; Summary of the New York Plan for Developing and Preserving State Forest Land; Summary of the Taylor Grazing Act; Montana Grazing Laws of 1935, Chapter 195; Montana Grazing Laws of 1935, Chapter 194; New Mexico Legislation Relating to Underground Water; Uniform Underground Water Law for Western States Suggested by a Committee of the Western State Engineers' Association; A Brief Bibliography for the Non-Professional Reader.

RANGE IMPROVEMENT BY WATER SPREADING

(*Continued from p. 270*)

Drainage area of about 2 square miles on San Francisco Creek, above diversion dam. Good cover such as this extends almost to the rim rock below the mesa, which is fully 2,500 feet above the dam. The photograph was taken from the dam.

with our work at the Mexican Springs Experiment Station. Likewise, the 100 dams, diversion ditches, and spreaders are all doing their duty in the control of erosion and in protecting the neighbors lower down the drainage system from periodical floods.

"All we have to do is to lead the water to the high places, and gravitation does the rest", said Louis Cortese, "so wherever we find a low place we run a spreader furrow from it on to the next high place. Now we never have to attend an irrigation, because the spreaders do the job automatically. If we can be assured of four runs of water lasting 4 hours, occurring at regulated intervals, during the summer, we can be assured of 400 tons of hay and ample pasture under this scheme. We find, also, that closely spaced water holes usually save us grass and flesh on our cattle. We arrange it so our cattle have no more than a half-mile to travel for water."

Profitable Market for Hay

Each fall these men buy 600 head of white-faced weaners, and these are sold again late the next spring after having wintered on the Cortese pastures and hay. By this program they sell their hay and grass in the most economical way possible, and at the same time the manure from the calves returns a rich food to the soil. "We've been at this job for 20 years", Louis Cortese told us, "but it has paid. It's taken a lot of elbow-grease and a lot more patience, and we learned years ago that a ranch won't pay if the owner hangs around the towns. We've made flood-control work a winter's job, and we arrange our ranch set-up so we have time to do this. The additional hay and grass grown by just removing rock from our fields and pastures to build dams and the barn, paid for the labor in moving the rock."

Today there are trees and shrubs along San Francisco Creek channel, and gullies have filled up instead of growing into gulches. Springs have appeared in parts of the creek bed which formerly were dry as bones, and in place of the sparse stands of grama grass the higher-yielding western wheatgrass has taken strong hold.

As for the contrasting streams, Frijole and San Francisco Creeks, the formera waits still a pair of Corteses. Given owners with stout hearts, discernment, and a knowledge of best stream-control methods, Frijole could, within 20 years or less, match her sister basin in the matter of fine pasture, heavy hay, and fat cattle.

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Studies in Economics Which Bear on Soil Conservation

For REFERENCE
Compiled by Mrs. ETTA G. ROGERS, Publications Unit

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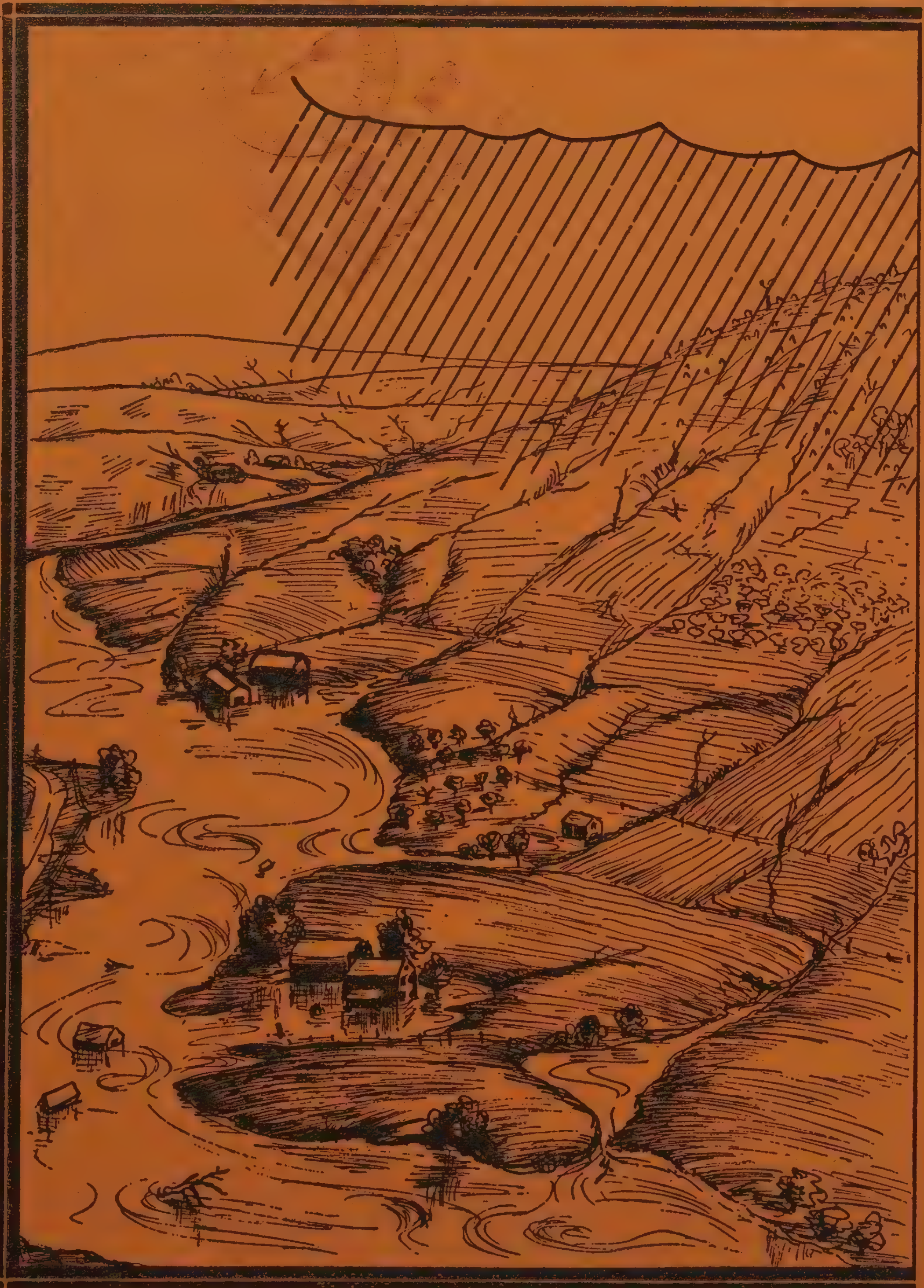
DEVASTATION



CONSERVATION

UNITED STATES DEPARTMENT OF AGRICULTURE

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